

Staying Functionally Independent

Understanding and Improving Independence in Older Adults



Esther Molenaar

Staying Functionally Independent

Understanding and Supporting Functional
Independence in Older People

Esther Molenaar

The printing of this dissertation was supported by HU University of Applied Sciences Utrecht, the Scientific College Physical Therapy (WCF) of the Royal Dutch Society for Physical Therapy (KNGF), and Molenaar Laboratory Information Consultancy (MLIC).

ISBN: 978-94-6522-736-8
Cover design: Letters Reclamebeletteraars | www.letters.nl
Lay-out: Maya Schutte | www.mayaschutte.com
Printing: Ridderprint | www.ridderprint.nl

Copyright © Esther Molenaar, 2025

All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, without prior permission from the author.

Staying Functionally Independent

Understanding and Supporting Functional
Independence in Older People

Zelfstandig blijven functioneren

Inzicht in en ondersteuning van fysieke
zelfredzaamheid bij oudere personen

(met een samenvatting in het Nederlands)

Proefschrift

ter verkrijging van de graad van doctor aan de
Universiteit Utrecht
op gezag van de
rector magnificus, prof. dr. ir. W. Hazeleger,
ingevolge het besluit van het College voor Promoties
in het openbaar te verdedigen op

dinsdag 20 januari 2026 des middags te 2.15 uur

door

Esther Adriana Lena Maria Molenaar

geboren op 8 juli 1985
te Prinsenbeek

PROMOTIECOMMISSIE

Promotoren:

Prof. dr. C. Veenhof

Prof. dr. N.J. de Wit

Copromotoren:

Dr. N. Bleijenberg

Dr. J.A. Barten

Beoordelingscommissie:

Prof. dr. M.H. Emmelot-Vonk (voorzitter)

Dr. J.S.M. Hobbelen

Prof. dr. T.J. Hoogeboom PhD

Prof. dr. A. van Royen-Kerkhof

Prof. dr. H. Schers

TABLE OF CONTENTS

Chapter 1	General Introduction	6
Chapter 2	Functional Independence in the Community Dwelling Older People: a Scoping Review	20
Chapter 3	Discriminative Validity of the Core Outcome Set Functional Independence in a Population of Older Adults	40
Chapter 4	Cluster Analysis of Functional Independence in Community-Dwelling Older People	64
Chapter 5	Psychometric Evaluation of the Decision Support Tool for Functional Independence in Community-Dwelling Older People	86
Intermezzo	From conceptualisation to implementation: Development and application of the DST-FI	108
Chapter 6	Exploring Feasibility and Acceptance of the Functional Independence Decision Tool Among Physical Therapists and Older Persons	112
Chapter 7	Exploring Barriers and Facilitators for the Potential Implementation of the Decision Tool-Functional Independence in Primary Care	138
Chapter 8	General Discussion	168
Chapter 9	Summary	182
	Nederlandse Samenvatting	188
	Authors' Contributions	192
	PhD Portfolio	194
	About the Author	201
	Dankwoord & Acknowledgements	202

Chapter 1

General Introduction

A CASE TO CONSIDER

Mrs. Jansen is 74 years old and lives with her husband in a ground-floor flat. She remains fairly active: she walks daily, performs light household tasks, and enjoys working in her small vegetable garden. However, she starts to notice that standing up from a chair requires more effort than before, and she recently gave up cycling after a near fall. Although she does not (yet) need assistance, she begins to avoid certain activities out of fear of losing her balance. While her general practitioner does not identify any immediate problems, Mrs. Jansen is clearly at risk of functional decline, a gradual process that may lead to a loss of functional independence.

(GLOBAL) AGEING

The World Health Organization (WHO) has identified ageing of the population as one of the most significant medical and socio-demographic challenges. Addressing this issue is considered a key priority in senior care worldwide (1). Population ageing refers to the increase in the number and percentage of persons aged 65 years and over. At the same time, the number and percentage of the young population, aged 15 years and under, decrease in the population structure (2). There will be more people aged 60 and over than adolescents aged 10–24 (2.1 billion compared to 2.0 billion), with population ageing reaching 38 percent globally. This demographic shift changes the way societies function. It affects not only the economy, but also politics and social structures. For instance, there is increasing concern about the sustainability of intergenerational social support systems, which are vital for the well-being of both older and younger generations (3). This issue is exacerbated by shrinking family sizes and the rise in female workforce participation. Traditionally, women have been the main caregivers (4). In South European countries, informal care is more common due to cultural expectations and lower rates of full-time female employment. In contrast, the Netherlands relies more heavily on formal care (5). These demographic and societal shifts contribute to rising healthcare costs, reduced quality of care, and persistent labour market shortages. As life expectancy increases, retirement periods need to be extended. This puts pressure on social security systems, which must adapt to remain sustainable (6). Currently, Japan, Finland, and Italy have the world's oldest populations, while countries such as Greece, Portugal, China, and Korea are experiencing the fastest ageing rates (6). Although the pace varies, almost all countries are already experiencing population ageing. These global trends are also evident in the Netherlands, where ageing is already affecting levels of independence and increasing the demand for long-term care (7).

A consequence of the demographic shift is that it leads to declining Functional Independence (FI) and places increasing pressure on long-term care services (8). In the Netherlands, healthcare expenditure is expected to grow from €12.7 billion in 2014 to €22.1 billion by 2030 (9). In response to the ageing population, both the demand for residential care and community-based services is expected to rise. While the cost of residential care will likely continue to grow due to increasing care intensity and staffing needs, the demand for home-based care is also increasing. For example, the number of people receiving community nursing is expected to grow by 2.6% per year, reaching

nearly 800,000 by 2033 (10). These trends underscore the growing pressure on the primary care system and the importance of timely, function-oriented support to help older people maintain their independence and avoid unnecessary institutionalisation (11).

The ageing individual

In addition to the societal and financial impacts of aging, there are direct consequences for the individual. Biologists define aging as a continuous process that begins at conception and continues until death (12). In Figure 1, the continuous process of aging is presented in a simplified model.

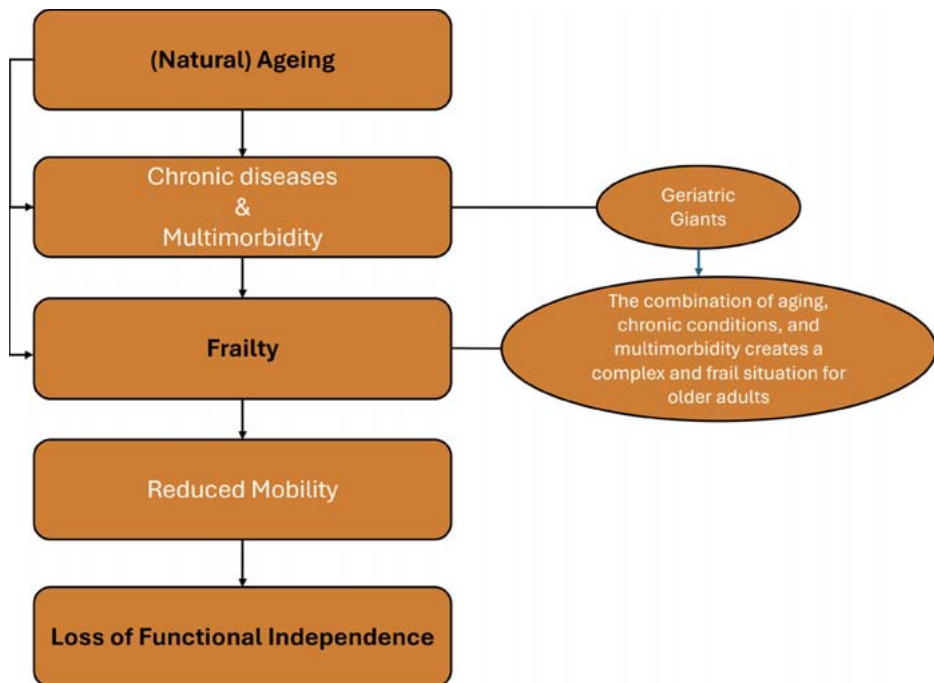


Figure 1: A cascade of aging processes and the increased likelihood of chronic conditions affect the level of Functional Independence. Adapted from Clegg et al. (2013) (13).

Although there is no uniform definition of biological ageing to date, the **natural ageing** process is generally characterised by loss of muscle strength, reduction in cardiovascular capacity, joint mobility, a decline in cognitive capacity, and reduced neurological function. Over time, this leads to an increasing incidence of physical, mental, and functional problems, as well as age-specific mortality rates (14,15). These changes may manifest as increased levels of central and peripheral fatigue, decreased flexibility, and a decline in quality of life due to loss of function and inability to manage daily activities (16).

With advancing age, the likelihood of developing **chronic diseases** significantly increases due to the cumulative effects of biological ageing processes and long-term exposure to various risk factors. Many studies agree that chronic diseases are characterised by a non-self-limiting nature, persistent and recurring health problems, anatomical and functional limitations, and a prolonged duration (months or years rather than days or weeks)(17) . In the Netherlands, over 10.4 million people (59% of the population) had a chronic condition in 2022 (17). Among those aged 75 and older, this percentage was as high as 96% (18). **Multimorbidity** involves the presence of two or more chronic diseases in the same person, with conditions that often interact and exacerbate each other (19). In the Netherlands, the percentage of people registered with two or more chronic conditions is projected to increase from nearly 25% in 2015 to 30% by 2040. This rise is largely attributable to the growing number of people aged 80 and older (20).

In addition to the increasing prevalence of chronic conditions and multimorbidity, there is also a rise in the number of older persons affected by so-called **geriatric giants** — chronic, multisystem, progressive disorders that lead to functional limitations and reduce quality of life (21). These include mobility disorders and falls, visual and auditory impairments, depression, dementia, and incontinence (22).

Chronic conditions, multimorbidity, and geriatric giants contribute to higher levels of frailty and more complex care needs among older persons. These conditions often require extensive treatments, involvement of multiple healthcare providers, and the use of various medications, which further complicates care. **Frailty**, in turn, can both result from and exacerbate these conditions. According to Gobbens et al. (2010), frailty in older persons arises from physical, psychological, and/or social deficits in functioning, which increase the likelihood of negative health outcomes (23). This common geriatric syndrome is linked to adverse outcomes such as chronic diseases, reduced mobility, and a heightened risk of falls (24).

Furthermore, frailty and underlying chronic conditions often lead to reduced mobility, which encompasses aspects such as bed mobility, transfers, and walking ability (25). The loss of mobility can significantly impact the daily functioning and quality of life of older people (26). Maintaining mobility helps older people to preserve their independence longer, thus reducing their reliance on others for daily activities (27). These physical and functional consequences of ageing are both common and gradual, making them difficult to detect. Yet they pose a serious threat to older people's ability to live independently. Early identification and support are essential to maintaining this ability, referred to as **Functional Independence** (FI), which is key to health, autonomy, and quality of life in later life (28).

FOCUS ON FUNCTIONAL INDEPENDENCE

Increasingly, governments incorporate strategies into their healthcare policies to help older individuals maintain their (functional) independence. In the Netherlands, this is visible in national policy initiatives such as the Living, Support and Care for Older People programme (Wonen, Ondersteuning en Zorg voor Ouderen, WOZO), the Right Care in the Right Place initiative (De Juiste Zorg op de Juiste Plek), and the Integrated Care Agreement (Integraal Zorgakkoord, IZA) (29). Together, they offer a long-term transition plan to prepare the Netherlands for demographic and healthcare challenges. This transition is called **Appropriate Care** and has four underlying principles (Figure 2). It aims to ensure that individuals receive the care they need, tailored to their specific conditions and circumstances, including those related to chronic diseases and geriatric giants (30). Appropriate care goes beyond treatment; it equally prioritizes health promotion and disease prevention. Appropriate care focuses on effective, affordable care close to the patient's living environment, encourages the use of digital tools, and fosters collaboration between healthcare and social service professionals (31). By involving patients in shared decision-making and supporting their autonomy, appropriate care supports people's autonomy and independence. For individuals with (or at risk of) functional impairments, this means care will primarily aim to maintain and optimize FI (32).

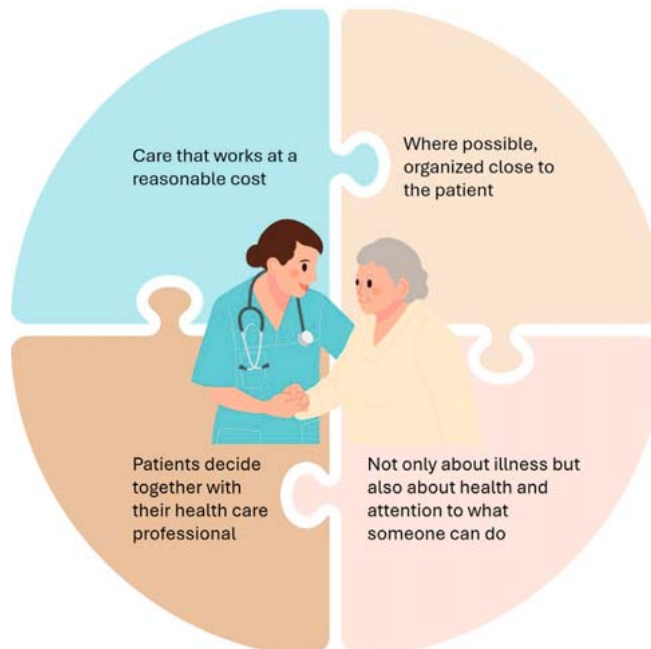


Figure 2: Four principles of appropriate care according to the Kader Passende Zorg of the Zorginstituut Nederland (33).

The concept of Functional Independence

Functional Independence (FI) is a dynamic concept that reflects how chronic conditions, multimorbidity, and frailty interact with a person's behaviour, needs, and abilities. It refers to the ability to adapt physically and maintain personal autonomy (34). This encompasses skills related to Activities of Daily Living (ADL), such as dressing, bathing, and basic mobility, as well as Instrumental Activities of Daily Living (IADL), including tasks like grocery shopping and cycling, with or without technological support. Currently, interpretations of FI predominantly emphasise physical aspects (34-37). Although FI is significantly influenced by physical capabilities, it extends beyond the physical domain and should be understood from an integrated perspective. Conceptual models such as the International Classification of Functioning, Disability and Health (ICF) emphasise that, in addition to physical abilities, personal and environmental factors are essential to maintain FI in older people (38,39). Therefore, understanding, operationalising, and maintaining FI in older people calls for collaboration between various clinical experts and underlying knowledge areas. To improve collaboration across disciplines and reduce the risk of functional decline, a shared definition of FI is needed: one that integrates physical, personal, and environmental factors. Such a definition is currently lacking (40).

This lack of conceptual clarity also makes it difficult to translate personalised care into daily practice. Delivering personalised care in the context of FI is widely regarded as essential, but difficult to operationalise in daily practice (41). While tailored support, attuned to an individual's health status, preferences, and living context, is key to achieving personalised outcomes, its implementation is often constrained by limited resources, workforce capacity, and scalability. Standardised care models, by contrast, offer efficiency and consistency but often fail to address individual needs (42). A promising intermediate approach is profile-based care: grouping older people based on shared characteristics or levels of need (43). This offers a structured yet responsive approach for individual care delivery and may be particularly relevant in supporting FI.

Measuring Functional Independence

Once there is consensus on the concept of FI, professionals need a clear and consistent way to assess the level of FI in individual older persons. Such measurement is essential for determining whether someone can maintain or improve their independence and whether professional support is needed. Reliable and standardised assessment enables timely interventions and supports appropriate care planning (44,45). Several instruments are currently used by healthcare professionals to assess the level of FI. Common examples include the Functional Independence Measure, the Barthel Index, and the Katz Index of Independence in Activities of Daily Living (46-48). These tools are primarily used by physiotherapists, occupational therapists, nurses, and physicians to evaluate physical functioning, for instance, the ability to rise from a chair or walk short distances. Since the concept of FI exceeds the borders of the physical domain, its measurement also requires an integrated perspective.

To support multidisciplinary and integrated care, there is a need for a reliable and broadly applicable measurement tool that extends beyond the physical domain (39). Such a tool should be easy to use in daily practice across professional roles, and ideally include a digital component to facilitate data sharing and coordination of care (49). Operationalising FI in this way is essential to enable timely and appropriate support care at the right place and at the right time.

Maintaining & Improving Functional Independence

After assessing the level of FI in an older individual, the next challenge is to tailor support to their individual needs (39). Given the dynamic, complex, and highly individual nature of FI, a personalised approach is essential, one that aligns with the principles of appropriate care (30). Clustering older people with similar levels of FI may help translate this principle into practice (50,51). To achieve this, we first need insight into the variation within this population and to identify distinct subgroups (52). These insights can inform timely and personalised interventions to match care strategies to FI profiles (53).

To effectively support older people in maintaining FI, it is not enough to assess their level of FI once. Commonly used instruments such as the Katz Index and the Barthel Index are primarily diagnostic and not intended to support ongoing monitoring (47,48). What is needed is a practical, broadly applicable instrument that enables professionals to measure, monitor, and act upon changes in FI over time. Such a tool should support not only initial assessment, but also follow-up and care planning, integrating physical, personal, and contextual factors. This creates the foundation for a more proactive, personalised, and interdisciplinary approach to FI.

The Need for a Decision Tool

Decision-support tools offer a promising way to translate a proactive, personalised, and interdisciplinary approach to Functional Independence (FI) into everyday practice (54,55). These tools can guide professionals in classifying older people into relevant FI profiles and in selecting care strategies tailored to their needs. Prior research has shown that decision-making tools such as decision trees can support clinical reasoning, improve the delivery of personalised care, and enhance adherence to care standards (56-58). Moreover, they are particularly valuable in interdisciplinary contexts (59,60).

There is a strong demand among professionals for the development of a **Decision Support Tool for Functional Independence (DST-FI)** (Figure 3). This proposed tool is intended to support multidisciplinary teams by covering all relevant domains of FI and facilitating coordinated care across disciplines.

The DST-FI will comprise three subsequent steps:

- (I) **measuring** a person's level of FI,
- (II) **matching** to one of the FI profiles, and
- (III) **generating** tailored treatment recommendations.

By way of this composition, the DST-FI can guide professionals in classifying older people into relevant FI profiles and in selecting care strategies tailored to their needs.

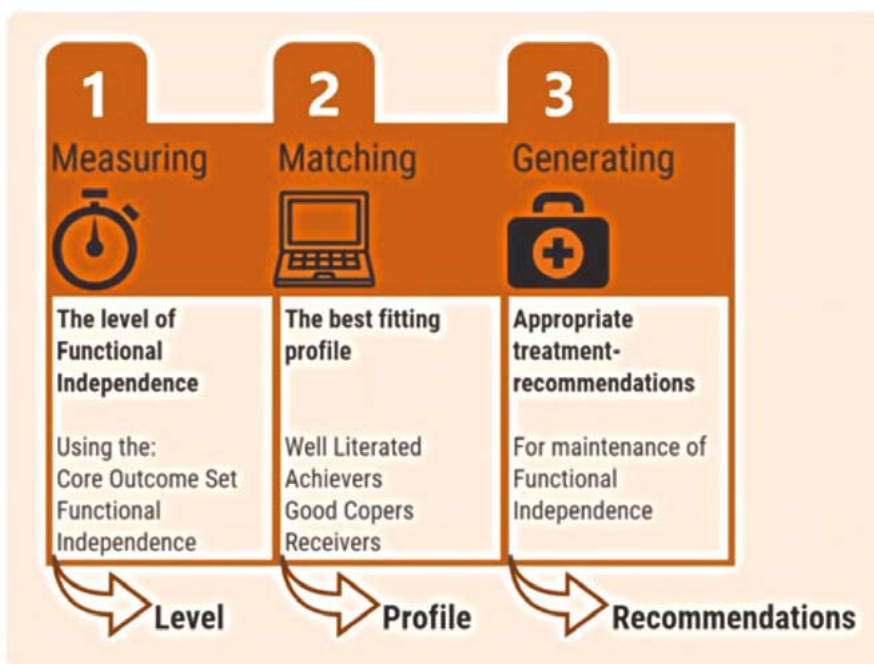


Figure 3: Mechanism of action of the Decision Support Tool for Functional Independence; The DST-FI will comprise three subsequent steps: (I) measurement of a person's level of FI, (II) allocation to one of the FI profiles, and (III) generation of tailored treatment recommendations.

Ensuring Validity and Practical Value of the Decision Support Tool- Functional Independence

The DST-FI, developed within the timeframe of the current thesis, serves as a practical tool to help professionals monitor and promote FI in older people. While it builds on validated assessments and prior research, the tool itself, including its subgroup classifications and corresponding recommendations, has not yet been psychometrically evaluated.

To support its use in daily practice and build trust among healthcare professionals, it is crucial to assess whether the tool provides accurate and clinically relevant guidance. Specifically, the credibility of the FI profiles and the validity of the associated care recommendations should be examined to determine their applicability in primary care.

Implementation of the Decision Support Tool for Functional Independence

Developing a tool such as the DST-FI is an essential step toward enabling appropriate care for older people. However, its actual impact will depend on successful and sustainable implementation in daily practice. Literature on the implementation of healthcare innovations emphasises the need for a systematic and evidence-based approach, especially in the context of primary care (61,62). A key factor in this process is the perceived added value for end users. For instance, if professionals do not experience the tool as useful or usable, implementation is unlikely to succeed (63). To prepare for the implementation of the DST-FI in daily practice, it is important to gain early insights into its usability, fit with existing care routines, and perceived relevance will help refine the tool and adapt it to professional needs.

In addition, attention must be given to broader contextual factors that affect implementation beyond the tool itself. These include organisational readiness, interprofessional collaboration, financial structures, and the wider policy environment. Mapping such barriers and facilitators is a necessary step toward future integration of the DST-FI in primary care, and toward realising its potential to support appropriate, personalised care for older people.

Objectives and outline of this thesis

The primary objective of this thesis is to improve the understanding of FI in older people and to develop tools that support healthcare professionals in optimising and maintaining FI.

Chapter 2 presents a scoping review and expert consultation aimed at developing a comprehensive and integrated definition of FI. This chapter addresses a conceptual gap: although the term is widely used, a clear and shared understanding of FI is lacking in both research and professional practice.

Chapter 3 focuses on the measurement of FI. It describes the validation of the Core Outcome Set for Functional Independence (COSFI), a tool designed to support consistent, interdisciplinary assessment of FI in older people. This chapter addresses the methodological gap of lacking valid and interpretable outcome sets that can be used across professional boundaries.

Chapter 4 presents a cluster analysis of FI in community-dwelling older people. Identified, distinct FI profiles serve as the basis for developing a Decision Support Tool for Functional Independence (DST-FI). This chapter addresses the need for tailored guidance by distinguishing meaningful profiles within the older population, which is essential for delivering personalised and appropriate care.

Chapter 5 reports on a psychometric evaluation of the DST-FI. The chapter examines the validity and reliability of the tool's recommendations based on the previously identified FI profiles. It aims to determine whether the DST-FI can be responsibly used to support clinical reasoning and decision-making in primary care.

In between Chapters 5 and 6, an **intermezzo** is included. This intermezzo consists of two parts. The first illustrates how the DST-FI can be applied in clinical scenarios, while the second reflects on the development process of the tool, from conceptualisation to implementation. Together, they provide additional context to better understand the practical relevance and development of the DST-FI.

Chapter 6 explores the perceived usability and feasibility of the DST-FI in clinical practice, based on first experiences of healthcare professionals. It addresses the need to understand how the tool fits into existing workflows and how professionals assess its added value in supporting their care for older people.

Chapter 7 investigates broader implementation conditions for the DST-FI by mapping context-specific barriers and facilitators. This includes factors related to the organization, interprofessional collaboration, and external policy and financing structures. This chapter addresses the gap in understanding what is needed to integrate a tool like the DST-FI sustainably and effectively into daily practice.

Chapter 8, the general discussion, discusses the main findings, methodological considerations, and implications for research, clinical practice, and policy.

REFERENCES

- Rudnicka E, Napierała P, Podfigurna A, Męczekalski B, Smolarczyk R, Grymowicz M. The World Health Organization (WHO) approach to healthy ageing. *Maturitas* 2020 Sep;139:6–11.
- Organisation for Economic Co-operation and Development (OECD). Elderly population. 2014; .
- Khan HTA. Factors Associated with Intergenerational Social Support among Older Adults across the World. *Ageing Int* 2014;39(4):289–326.
- Singleton J. Women Caring for Elderly Family Members: Shaping Non-Traditional Work and Family Initiatives. *Journal of Comparative Family Studies* 2000 /09/01;31(3):367–375.
- Zimmer Z, McDaniel SA. *Global Ageing in the Twenty-First Century*. 1st ed. United Kingdom: Routledge; 2013.
- United Nations Population Division. *World Population Aging 1950–2050*.
- Bloom DE, Chatterji S, Kowal P, Lloyd-Sherlock P, McKee M, Rechel B, et al. Macroeconomic implications of population ageing and selected policy responses. *The Lancet* 2015;385(9968):649–657.
- Alders P, Schut F. Trends in ageing and ageing-in-place and the future market for institutional care: scenarios and policy implications. *Health Economics, Policy and Law* 2018;14:82–100.
- Eggink E, Ras M, Woittiez I. Dutch long-term care use in an ageing population. *The Journal of the Economics of Ageing* 2017;9:63–70.
- ActiZ. *De vraag naar wijkverpleging veel groter dan het aanbod*. 2024.
- Centraal Bureau voor de Statistiek (CBS). *Laatste levensjaren tachtigplussers*. 2020; .
- Zane F, MacMurray C, Guillermain C, Cansell C, Todd N, Rera M. Ageing as a two-phase process: theoretical framework. *Frontiers in Aging* 2024;5.
- Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. *Lancet* 2013 Mar 2;381(9868):752–762.
- Gompertz B. XXIV. On the nature of the function expressive of the law of human mortality, and on a new mode of determining the value of life contingencies. In a letter to Francis Baily, Esq. FRS &c. *Philosophical transactions of the Royal Society of London* 1825(115):513–583.
- Comfort A. *The biology of senescence*. 1956.
- Wagner SG, Pfeifer A, Cranfield TL, Craik RL. The effects of ageing on muscle strength and function: A review of the literature. *Physiotherapy Theory and Practice* 1994;10(1):9–16.
- Barrio-Cortes J, Castaño-Reguillo A, Beca-Martínez MT, Bandeira-de Oliveira M, López-Rodríguez C, Jaime-Sisó MÁ. Chronic diseases in the geriatric population: morbidity and use of primary care services according to risk level. *BMC Geriatr* 2021 Apr 26;21(1):278–7.
- Rijksinstituut voor Volksgezondheid en Milieu (RIVM). *Chronische aandoeningen in Nederland*. 2024; .
- Johnston M, Crilly M, Black C, Prescott G, Mercer S. Defining and measuring multimorbidity: a systematic review of systematic reviews. *Eur J Public Health* 2018;29:182.
- Hilderink H, Plasmans M, Poos R. Future Dutch DALYs as part of the Dutch Public health Foresight Study. *Eur J Public Health* 2023;33:ckad160.650.
- Bartoszek A, Niedorys B, Szalast K. Geriatric giants among the elderly. *J Educ Health Sport* 2019;9(4):367–374.
- Bartoszek A, Niedorys B, Szalast K. Geriatric giants among the elderly. *J Educ Health Sport* 2019 /04/14;9(4):367–374.
- Gobbens RJ, Luijckx KG, Wijnen-Sponselee MT, Schols JM. Toward a conceptual definition of frail community dwelling older people. *Nurs Outlook* 2010;58(2):76–86.
- Kim DH, Rockwood K. Frailty in Older Adults. *N Engl J Med* 2024 Aug 8;391(6):538–548.
- Klerk Md. *Ouderen in instellingen. Landelijk overzicht van de leefsituatie van oudere tehuusbewoners* 2005.
- Guralnik JM, Patel K, Ferrucci L. Assessing Functional Status and Disability in Epidemiologic Studies. In: Newman AB, Cauley JA, editors. *The Epidemiology of Aging* Dordrecht: Springer Netherlands; 2012. p. 91–117.
- 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 geriatrics* 2011;11:1–11.
- Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. *The lancet* 2013;381(9868):752–762.
- Ministerie van Volksgezondheid W,en Sport. *Integraal Zorgakkoord 2022–2027*. 2022.
- Nederland Z. *Kader Passende Zorg*. Advies 2022.
- Nederland Z, Zorgautoriteit N. *Samenwerken aan passende zorg: de toekomst is nú*. Gezamenlijk

- Advies 2020.
32. Mortenson WB, Fuhrer MJ, Bilkey J, Jutai J, Alkadri J, Aziz J, et al. Comparing Assessments of Physical Functional Independence in Older Adults With Mobility Limitations. *Am J Phys Med Rehabil* 2019 Aug;98(8):637–641.
 33. Nederland Z. Kader passende zorg. Zorginstituut Nederland: Hague, The Netherlands 2022.
 34. Curzel J, Junior LAF, Rieder MdM. Evaluation of functional independence after discharge from the intensive care unit. 2013;25(2):93–98.
 35. 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* 2017 Oct 20.
 36. Clark BC, Manini TM. Functional consequences of sarcopenia and dynapenia in the elderly. *Curr Opin Clin Nutr Metab Care* 2010 May;13(3):271–276.
 37. Freedman VA, Martin LG, Schoeni RF. Recent trends in disability and functioning among older adults in the United States: a systematic review. *JAMA* 2002 Dec 25;288(24):3137–3146.
 38. Üstün TB, Chatterji S, Bickenbach J, Kostanjsek N, Schneider M. The International Classification of Functioning, Disability and Health: a new tool for understanding disability and health. *Disabil Rehabil* 2003;25(11-12):565–571.
 39. de Carvalho IA, Epping-Jordan J, Beard JR. Integrated care for older people; guidelines on community-level interventions to manage declines in intrinsic capacity. *World Health Organization* 2018:14–19.
 40. Sangaletti C, Schweitzer MC, Peduzzi M, Zoboli ELCP, Soares CB. Experiences and shared meaning of teamwork and interprofessional collaboration among health care professionals in primary health care settings: a systematic review. *JBHI Evidence Synthesis* 2017;15(11):2723–2788.
 41. Snyderman R. Personalized health care: From theory to practice. *Biotechnology Journal* 2012;7.
 42. Sinsky C, Bavafa H, Roberts R, Beasley J. Standardization vs Customization: Finding the Right Balance. *The Annals of Family Medicine* 2021;19:171–177.
 43. Looman WM, Fabbriotti IN, Blom JW, Jansen APD, Lutomski JE, Metzelthin SF, et al. The frail older person does not exist: development of frailty profiles with latent class analysis. *BMC Geriatrics* 2018;18(1):84.
 44. Farias M, Jenkins K, Lock J, Rathod R, Newburger J, Bates D, et al. Standardized Clinical Assessment And Management Plans (SCAMPs) provide a better alternative to clinical practice guidelines. *Health Aff* 2013;32 5:911–920.
 45. Lyndon H, Underwood F, Latour J, Marsden J, Brown A, Kent B. Effectiveness of nurse-coordinated, person-centered comprehensive assessment on improving quality of life of community-dwelling, frail older people: a systematic review protocol. *JBHI evidence synthesis* 2020;18 4:824–831.
 46. Kidd D, Stewart G, Baldry J, Johnson J, Rossiter D, Petruckevitch A, et al. The Functional Independence Measure: a comparative validity and reliability study. *Disabil Rehabil* 1995;17 1:10–14.
 47. Mahoney FI, Barthel DW. Functional evaluation: the Barthel Index: a simple index of independence useful in scoring improvement in the rehabilitation of the chronically ill. *Md State Med J* 1965.
 48. Wallace M, Shelkey M. Katz index of independence in activities of daily living (ADL). *Urol Nurs* 2007;27(1):93–94.
 49. Marwaha J, Landman A, Brat G, Dunn T, Gordon W. Deploying digital health tools within large, complex health systems: key considerations for adoption and implementation. *NPJ Digital Medicine* 2022;5.
 50. Wu W, Sun L, Li H, Zhang J, Shen J, Li J, et al. Approaching person-centered clinical practice: A cluster analysis of older inpatients utilizing the measurements of intrinsic capacity. *Frontiers in Public Health* 2022;10.
 51. Pambet M, Gauvain J, Valéry A, Annweiler C, Mandigout S, Fougère B, et al. Use of a clustering method to describe the clinical profiles of older fallers: the value of a multidisciplinary consultation. *European Geriatric Medicine* 2023;14:1097–1104.
 52. Rijdsdijk M, Smits HM, Azizoglu HR, Brugman S, van de Burgt Y, van Charldorp TC, et al. Identifying patient subgroups in the heterogeneous chronic pain population using cluster analysis. *The Journal of Pain* 2025;28.
 53. Bretos-Azcona P, Sánchez-Iriso E, Hita JC. Tailoring integrated care services for high-risk patients with multiple chronic conditions: a risk stratification approach using cluster analysis. *BMC Health Services Research* 2020;20.
 54. Gross D, Armijo-Olivo S, Shaw W, Williams-Whitt K, Shaw N, Hartvigsen J, et al. Clinical Decision Support Tools for Selecting Interventions for Patients with Disabling Musculoskeletal Disorders: A Scoping Review. *J Occup Rehabil* 2015;26:286–318.
 55. Chima S, Reece J, Milley K, Milton S, McIntosh J,

- Emery J. Decision support tools to improve cancer diagnostic decision making in primary care: a systematic review. *The British journal of general practice : the journal of the Royal College of General Practitioners* 2019.
56. Graham MM, James MT, Spertus JA. Decision Support Tools: Realizing the Potential to Improve Quality of Care. *Can J Cardiol* 2018 Jul;34(7):821–826.
 57. Butera KA, George SZ, Lentz TA. Psychometric Evaluation of the Optimal Screening for Prediction of Referral and Outcome Yellow Flag (OSPRO-YF) Tool: Factor Structure, Reliability, and Validity. *J Pain* 2020;21(5-6):557–569.
 58. Qin Z, Armijo-Olivo S, Woodhouse LJ, Gross DP. An investigation of the validity of the Work Assessment Triage Tool clinical decision support tool for selecting optimal rehabilitation interventions for workers with musculoskeletal injuries. *Clin Rehabil* 2016 Mar;30(3):277–287.
 59. Manca DP, Campbell-Scherer D, Aubrey-Bassler K, Kandola K, Aguilar C, Baxter J, et al. Developing clinical decision tools to implement chronic disease prevention and screening in primary care: the BETTER 2 program (building on existing tools to improve chronic disease prevention and screening in primary care). *Implement Sci* 2015 Aug 4;10:107–9.
 60. Davies N, Schiowitz B, Rait G, Vickerstaff V, Sampson EL. Decision aids to support decision-making in dementia care: a systematic review. *Int Psychogeriatr* 2019 Oct;31(10):1403–1419.
 61. Fernandez ME, Ten Hoor GA, Van Lieshout S, Rodriguez SA, Beidas RS, Parcel G, et al. Implementation mapping: using intervention mapping to develop implementation strategies. *Frontiers in public health* 2019;7:158.
 62. Huynh AK, Hamilton AB, Farmer MM, Bean-Mayberry B, Stirman SW, Moin T, et al. A pragmatic approach to guide implementation evaluation research: strategy mapping for complex interventions. *Frontiers in public health* 2018;6:134.
 63. Pratt R, Saman DM, Allen C, Crabtree B, Ohnsorg K, Sperl-Hillen JM, et al. Assessing the implementation of a clinical decision support tool in primary care for diabetes prevention: a qualitative interview study using the Consolidated Framework for Implementation Science. *BMC Med Inform Decis Mak* 2022 Jan 15;22(1):15–x.

Chapter 2

Functional Independence in the Community Dwelling Older People: a Scoping Review

Esther Molenaar, Di-Janne Barten, Saskia te Velde, Liedeke van Schoot,
Nienke Bleijenbergh, Niek de Wit, Cindy Veenhof

Journal of Population Ageing. 2023; 16; 243–262

DOI: [10.1007/s12062-020-09315-1](https://doi.org/10.1007/s12062-020-09315-1)

ABSTRACT

Ageing potentially poses a threat to independent functioning of older adults. Although clinicians commonly focus on physical factors limiting Functional Independence (FI), it is likely that personal and environmental interactions also seem important to maintain FI. Herewith, FI exceeds several professional borders and calls for a uniform, multi-disciplinary interdisciplinary supported definition of FI. This study aims to provide such a definition of FI in community dwelling older people. A scoping review was performed. Pubmed/Medline, Psychinfo and CINAHL were searched for studies describing aspects of FI. A literature-based definition of FI was discussed by experts (n = 7), resulting in a formulated final definition of FI and insight into contributing factors to FI. A multidisciplinary focusgroup a stakeholder consultation (n = 15) ensured clinical relevance for daily practice. Data from the focusgroup stakeholder consultation were analyzed by using Atlas.ti (version 8). Based on the literature search, 25 studies were included. FI was finally defined as “Functioning physically safely and independent from another person, within one’s own context”. The contributing factors of FI comprised physical capacity combined with coping, empowerment and health literacy. Moreover, the level of FI is influenced by someone’s own context. This study confirms the relevance of the physical aspect of FI, but additionally stresses the importance of psychological factors. In addition, this study shows that one’s context may affect the level of FI as well. This underlines the importance of a holistic view and calls for multidisciplinary interdisciplinary collaboration in community-dwelling older people.

Keywords: Functional independence · Older adults · Independence · Interprofessional relations · Patient centered care · Prevention · Holistic care

INTRODUCTION

Ageing and the accompanying long-term diseases in the older population potentially pose a threat to self-sufficient functioning of older adults in their own environment. Following a downward spiral, the progressive deterioration in physical capacity associated with ageing may lead to physical frailty and for instance a higher risk on falling. Subsequently, this physical decline causes limitations both in functional performance and (instrumental) daily life activities. In the end, someone's 'Functional Independence' (FI), is at stake (1,2,3). FI has been described as the ability of an individual to perform activities of daily living (4). Several studies have shown that older adults with limitations in their FI make disproportionate use of hospital services (5). Early insight into factors limiting individuals' FI may contribute to better preservation of daily life activities and to use less of health care services. It may also facilitate older people in living independently, in their own environment for as long as possible (6). Moreover, monitoring FI is in line with current health care policy promoting self-sufficiency to maintain quality of life in older people. Finally, focusing on patient's FI may include a shift from the relatively expensive secondary health care towards less expensive primary care (3,7-9).

At this moment, different instruments are already available for clinical healthcare professionals to assess factors limiting FI and to evaluate someone's FI in daily life activities (10). Examples are the Functional Independence Measure, the Barthel index and the Katz Index of independence in activities of daily living (11-13). Those instruments are commonly used in clinical practice by several professionals who are involved in the issue of FI. Physiotherapists, occupational therapists, nurses and physicians use those instruments to specifically assess the physical aspect of FI. However, from an integrated health care perspective, it is likely that FI exceeds the physical domain. According to such an integrated health care model as the International Classification of Functioning, Disability and Health (ICF) it is likely that in addition to physical capabilities, personal and environmental interactions are equally important in maintaining FI of older people (14,15). At this moment, a clear definition of such an integrated concept of FI is lacking (16). To optimize interprofessional collaboration to prevent a decline in FI, a uniform, integral definition is required (17). We report the results of a scoping review and present an interprofessionally supported definition of FI and an ICF-structured overview of factors influencing FI in community dwelling older people.

METHODS

A scoping review was conducted, combining an explorative literature search with expert consultations, to develop a broad, interdisciplinary definition of FI. The five-stage framework for producing a scoping literature review, proposed by Arksey and O'Malley, was used as guidance (18,19). The subsequent steps will be described below.

1) Identifying the research question

The research questions were twofold: 1; to determine a clinically applicable, interprofessionally supported definition of FI in the community dwelling older people. 2; to determine which factors help to identify FI and the relationship between these factors. The overall aim was to create a comprehensive overview of FI for clinical practice, fitting to the integrative ICF framework.

2) Identifying relevant studies

To create a literature based definition of FI, a medical information specialist (LS) performed an extensive search in medical electronic databases MEDLINE, CINAHL and PsycINFO. The extended search strategy was presented in Table 1. Databases were searched from the date of database start until May 2017, an update of the search in MEDLINE was conducted in July 2019. Clinicians seem to commonly focus on physical factors limiting independence. Hence to get insight into the relationship and contributing factors the term “physical” needed to be combined with “independence” or a related term. In addition, the search was carried out for a vulnerable population. ‘Vulnerable’ was attributed by people with several chronic diseases who are at risk for diminished FI. The search was limited to publications written in English, Dutch or German.

3) Selecting the studies

Articles were considered eligible for inclusion when both an independence component and a physical component were described. Moreover, potentially eligible studies included a vulnerable population for losing FI as in suffering from a long-term disease, frailty or older of age. The operationalization of the independence component, physical component and vulnerability was presented in Table 1. Considering the explorative aspect of the review, all research papers were considered for inclusion. In general no exclusion criteria were applied. Prior to the selection process, duplicates were removed. Selection of eligible studies was performed following a drop-out procedure, starting with scanning of the study titles only, (20) followed by screening of the abstracts and in the end of the full-text articles against the selection criteria. The selection procedure was performed independently by two authors (EM and JAB). After each selection stage, differences in inclusion between the authors were resolved in a consensus meeting. Articles not available as full text were excluded, although corresponding authors were contacted when full text was not available online.

Table 1 Search strategy scoping review on Functional Independence July 2019

PubMed/Medline			
Mesh Terms	AND	AND	Restrictions
Human Activities M Activities of daily living M Physical activity M Independent Living M Exercise M	Health Behavior M Patient participation Self-Control M Self-efficacy M Self Care M= self-management Personal Autonomy M Internal-External Control M	Frail elderly vulnerable populations M Chronic diseases M Disabled Persons M	Restrict to MESH major topic, do not include MeSH terms found below this term in the MeSH hierarchy Language: NL/EN/DE Humans
Search terms	AND	AND	Restrictions
Physical Somatic Bodily	Self Sufficiency Sufficiency Self Confidence Self-powered Empowerment Self-Responsibility Self-maintenance Internal locus of Control or External locus of Control	Frail Vulnerable "Chronic disease" "Disabled"	Title/abstract Language: NL/EN/DE Humans
CINAHL	AND	AND	Restrictions
CINAHL Headings	AND	AND	Restrictions
Human Activities Community Living	Self-efficacy Self Care Self regulation Locus of control Consumer participation Health Behavior	Frail elderly Special populations Chronic disease Homebound Patients	Restrict to MESH major topic, do not include MeSH terms found below this term in the MeSH hierarchy Language: NL/EN/DE Humans

Table 1 (continued)

Search terms

Physical
Somatic
Bodily
Physiologic
Activities of daily living

Consumer participation
Health behavior
Locus of control
Patient participation
Personal Autonomy
Sufficiency
Self Confidence
Self-efficacy
Self Care
Self-powered
Empowerment
Self regulation
Self-Responsibility
Self-maintenance
Self-Control

Frail
Vulnerable
"Chronic disease"
"Homebound persons"

Psycinfo

Psycinfo Subject Headings

Activities of daily living SH
Physical mobility SH
Physical activity SH
Selfcare skills SH

AND

Self-efficacy SH
Self-confidence SH
Empowerment SH
Independence (personality) SH
Self-determination SH
Self-management SH
Self-Control SH
Client participation SH
Health Behavior SH
Internal-External locus of Control SH

AND

Geriatric patients SH
At risk populations SH
Chronic illness SH
Homebound SH

Restrictions

Search terms

Physical
Somatic
Bodily
Physiologic
Physical Activit*
Activities of daily living

self sufficiency
Self Confidence
Self-powered
Empowerment
Self-Responsibility
Self-maintenance

Frail
Vulnerable
"Chronic disease"
Chronic illness
Homebound

Title/abstract

Table 2 Data extraction table scoping review on Functional Independence

Author/ Year	Study design	Population	Relationship physical function and independence
(Alma et al., 2012)	CT	29 visually impaired persons (>55)	Previous research showed that vision loss has a profound impact on daily functioning and quality of life, as indicated by an impaired functional ability and psychological distress. WHO underlines the importance of Participation-defined as "involvement in life situations- as an outcome of health. It is important that persons maintain or enhance their level of participation in society and.... independence
(Antmann et al., 2012)	validity /question list	Adults 473 (MS) and 253 (SCI)	Self-efficacy was found to be highly correlated with functioning (measured by the Stanford health assessment questionnaire) Self-efficacy: the belief in one's ability to produce the effects or outcomes one wants
(Andresen, Malmstrom, Miller, & Wolinsky, 2005)	study protocol	55 (65 years or older)	Perceived lack of control has been found to be determinably to physical health
(Arends, Bode, Taal, & Van de Laar, 2013)	study protocol	Adults with polyarthritits	Suffering a chronic disease increases the risk for the development of secondary conditions and disabilities that often lead to further declines in health status, independence, functional status, life satisfaction, and overall quality of life.
(Ashe, Eng, Miller, & Soon, 2007)	descriptive cross-sectional	200 (65-90) 2 or more chronic diseases)	Common impairments in multiple domains (capacity and self-efficacy) may limit activity participation in a similar way across different chronic diseases
(Borg, Hallberg, & Blomqvist, 2006)	randomly cross-sectional survey	522 (65-89 years old with reduced self-care capacity)	It may well be that the transition from being healthy and independent of help with activities of daily living to having to live with reduced self-care capacity alters the view of aspects contributing to life satisfaction. Factors sign. Predicting low life satisfaction: severe (OR3:3) and totally impaired (OR 4:3)
(Boyle & Sielski, 1981)	Cross-sectional design	111 (older institutionalized veterans)(M age 59,5 SD 13,5)	Health locus of control correlated with Physical Self indicating that health internality was associated with more positive self-assessment of physical well-being
(Buck, Poole, & Mendelson, 2010)	cross-sectional study	62 (with scleroderma Mean age:52.9 SD 11.7)	Self-efficacy has been linked to functional ability. Self-efficacy has been shown to determine how one will manage a chronic disease. Participants who had higher levels of functional disability had lower self-efficacy
(Cardol et al., 2002)	cross-sectional	126 (M age 52 SD 13,4)	Disability in ADL explained a small part of the restrictions in participation in the domains family role and social relations

Table 2 (continued)

(Collins & O'Mahony, 2015)	qualitative, narrative approach	8 (adults with physical disability such that performing activities of daily living and mobility without the assistance of others isn't possible)	Adults with physical disability such that performing activities of daily living and mobility without the assistance of others is not possible. This group may have specific needs and experiences around autonomy in their daily life.
(Collins, 2017)	Original article	None	Professionals tend to define independence in terms of self-care activities. So, independence is measured against skills in relation to performance of these activities.
(Dirik, Cavlak, & Akdag, 2006)	cross-sectional	133 (65-90 healthy older persons)	In the elderly dependency stems from physical, emotional, social or mental changes. Muscle strength, muscular endurance, balance, flexibility and coordination are very important to improve independency in daily living activities and to enhance the quality of life in elderly people (Lewis and Bottomley 1994, Cavlak and Buker 2004)
(Doba et al., 2016)	cross-sectional	257 (82.3 SD3.8)	Self-efficacy is increasingly being recognized as an essential component of well-being. Additionally, the authors pointed out several concerns in relation to self-efficacy in older adults with aging, physical functioning, disabilities and illnesses
(Faul et al., 2009)	quasi-experimental	86 (76.64 SD 6.78) independent elderly	Functional status and physical mobility refers to how independent individuals are within their environment.
(Gignac, Cott, & Badley, 2000)	cross-sectional	286 (55y and older with osteoarthritis and or osteoporosis)	Dependence is depicted as being associated with practical helplessness, a state of need, incompetence, and functional incapacity. Discussions of independence typically emphasize personal characteristics such as self-regulation, control, and the ability or opportunity to make choices about important aspects of one's life.
(Gronstedt et al., 2011)	cross-sectional	322 (M 85 years) residents from nursing homes)	One's belief in one's own ability, such as self-efficacy, can serve to impair or enhance performance. The relationship between self-regulatory factors and performance may be especially important for older adults. Physical frailty may be used to define the population at high risk of disability onset or progression.
(Harrison, 2002)	cross-sectional	50 (50-84y old women with OA of the knee)	The fact that no disease-modifying therapies have been identified for OA may compel the person who is addicted to more fully integrate coping strategies from the psychosocial and spiritual domains. In time, these domains may become inseparable components of the pathology itself, providing a complex relationship between the pathology and functional outcomes.

Table 2 (continued)

(Janke, Son, & Payne, 2009)	cross-sectional	178 (between 51-95)	Ways that individuals can manage this chronic condition to maintain or even improve their health. Successful self-regulation and adaptation of activities (e.g. household, family, work, leisure) can positively impact one's health and well-being according to the SOC model. An individual's ability to select among activities, optimize their participation, and compensate or adapt activities may vary based on sociodemographic characteristics.
(Jenkins & Gortner, 1998b)	prospective cohort design	199 (at least 70, M 75.8)	A belief in one's capability to exercise control over actions and over environmental demands. Self-efficacy theory proposes a reciprocal relationship between belief, action, physiological state, and environmental influences. Actual behavior performance (enactment) is often the most potent source of efficacy information, particularly for behaviors that are psychomotor in nature.
(Marques, Jacome, Gabriel, & Figueiredo, 2013)	cross-sectional	371 (aged 65-103)	This age group (older adults) is at risk of functional decline, which is one of the highest threats for independency, given that it can lead into functional limitations and disability. Indeed, an estimated 20-30% of community-dwelling older adults report disability in instrumental activities of daily living (IADL) and basic activities of daily living (BADL), such as tasks essential to household management and tasks of basic self-care respectively.
(McAuley et al., 2006)	prospective study/ cross-sectional	249 older women (M 68.12 range 59-84)	Physical function performance involves a quantitative assessment of the behavioral act (e.g., walking speed), whereas functional limitations are perceived restrictions in the frequency of being able to carry out these activities.
(McAuley et al., 2007)	prospective study	249 (older women (M 68.1 range 59-84)	Self-efficacy an important social cognitive variable, is another potential mediator of the relationship between physical activity and functional limitations. Self-efficacy expectations are beliefs in ability to successfully perform specific courses of action and have been related to physical function performance and influenced by physical activity participation. Moreover, self-efficacy has been associated with disability and functional limitations.
(Overbeek et al., 2018)	Cross-sectional	200 frail, competent adults (median age 87 years)	Cross-sectional studies among populations with a range of conditions and economic backgrounds reported that adults' activation levels were positively related to their health status (e.g. health related quality of life, which refers to the perceived wellbeing in physical, mental and social domains of life), healthy behaviors (e.g. physical activity, healthy diet), appropriate use of healthcare systems (e.g. not delaying doctor visits) and satisfaction with care services.

Table 2 (continued)	(Richardson et al., 2012)	Intervention study	60 (persons with chronic illnesses (>44years M age 62, 78)	There is increasing awareness of the importance of functional status as a major health outcome as well as an emphasis on cost effective interventions for its enhancement. There is growing evidence that functional status data are vital to clinical practice and substantiate health system performance. Functional status as an outcome of care is a major concern for persons of all ages with chronic illness who are trying to self-manage their conditions. Loss of self-management abilities has been associated with loss in different functioning domains, including physical functioning.
	(Wei-Ju Lee et al., 2016)	cohort (6 years)	715 (community dwelling participants aged >54years M 66.5 SD7.3)	

4) Charting the data

To provide an overview of the included studies, study characteristics were extracted by identifying a study's authors, publishing date, study type, research design and the description or definition of FI (Table 2). Subsequently, the first author identified text fragments concerning FI by extensively reading the text, extracting the fragments from the included articles and identifying terms concerning FI by open coding and axial coding the text fragments according to the grounded theory (45). The gathered codes were plotted in a wordcloud (Fig. 2) to identify the most commonly mentioned codes. Subsequently, these codes were used to form a preliminary, literature-based definition of FI. Furthermore, a list of key-terms related to FI was gathered, mentioned in the medical literature, to detect potential factors contributing to FI.

5) Adding a clinical view and analyzing the data

To enhance the preliminary definition and to ensure its applicability in clinical practice, relevant stakeholders in the community were consulted. Prior to consultation of stakeholders, the results of the literature review were structured by researchers and lecturers who are involved in the domain of functional independence ($n = 7$). Initially, this group was asked to reach consensus on the definition of FI in a guided focus-group discussion facilitated by the first author. Second, to gain insights into related factors of FI, the list of key-terms found in the literature was presented to the group. To involve the participants in developing an overview of related factors we used two different Participatory Learning Action techniques. With the direct ranking technique we asked participants which terms they thought contributed mostly to the definition of FI (46). Participants were allowed to skip terms from and add terms to the list. To categorize these key terms, we used the card sort method, to democratically let the participants divide the key-terms into different main themes (47). This eventually led to a first overview of related factors influencing FI.

Subsequently, a stakeholder consultation was organized to assure the clinical relevance of the FI concept for clinical daily practice. This online consultation took place in the autumn of 2019 and involved community dwelling older persons ($N = 4$) and varying healthcare providers in community care such as occupational therapists ($n = 2$), physical therapists ($n = 2$), (district) nurses ($n = 4$), physician ($n = 1$). Participants were recruited by inviting professionals who are linked to two local networks of community-care professionals through a personal e-mail. In addition, social media was used to recruit community-care professionals as well. Professionals were eligible to participate when they were involved in treatment of older people in the community. Participating professionals were requested to recruit community-dwelling older people from their professional practice. After agreement on participation participants received a personal link to provide access to the online environment which required a password. Participants were asked what their personal association was with each contributing factor to the concept of FI. Answers were discussed in the group until consensus was reached. Finally, they were asked if the factors influencing FI were adequate and if they found factors missing. Data-analyses were performed by using Atlas.ti. (version 8). First open source labeling (45) was done by the first author. Second, the first two authors separately categorized

these labels, outcomes were compared and discussed. Finally, the categories were added to the already obtained results and a graphic representation of FI was formed by these authors. The graphical representation adhered to the ICF framework where possible.

RESULTS

Study Selection

The search strategy initially resulted in a total of 1905 unique articles. After the screening process, 25 studies were eligible for inclusion. The most common exclusion criterion was a single focus on independence in general or physical output, instead of describing a physical component in relation to independence (Fig. 1).

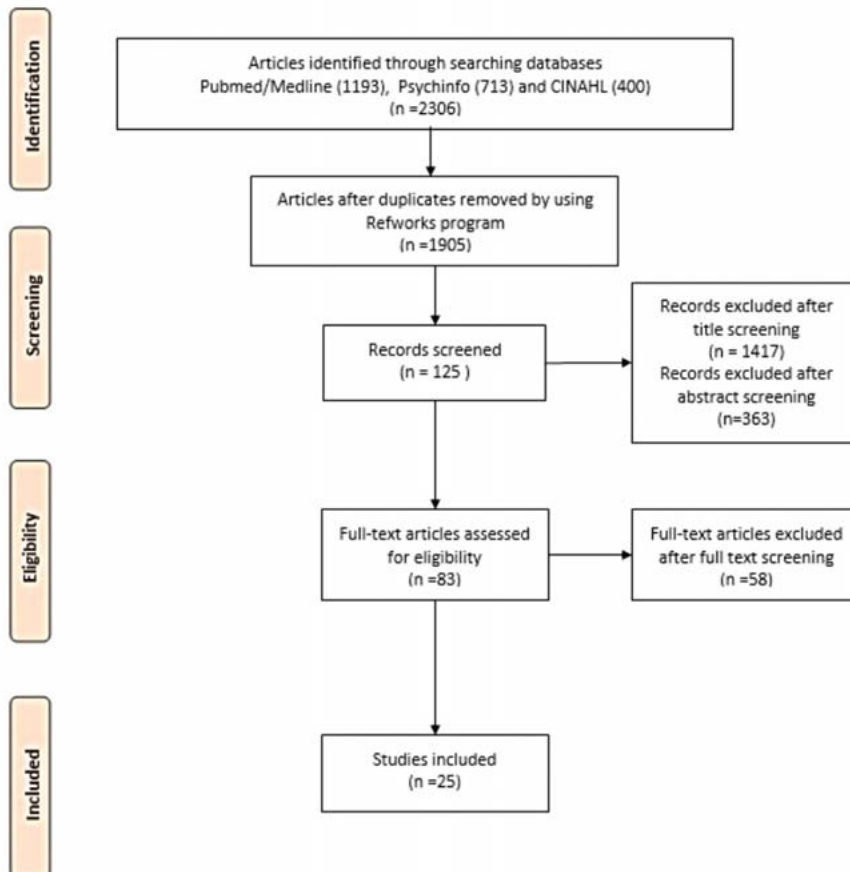


Fig. 2 Wordcloud search results from the scoping review on Functional Independence

Charting the Data

Ten studies were published over the last decade, 11 between 2000 and 2010 and only one of the studies was performed during the 90's. Most studies ($N = 12$) were cross-sectional, almost half of the included studies ($n = 11$) focused on older adults (>65 years). The most commonly used words for describing the combination of the physical component and independence in the literature were 'independency', 'ability', 'functional' and 'participation' (Fig. 2). Further categorization by the first author, led to a preliminary definition of FI as "functioning physically independent in activities of daily life". Furthermore, the list of key-terms (available on request) mentioned in relation to the definition of FI gathered from the literature, showed terms concerning different domains as physical capacity, social participation, psychological functioning and personal environment. By way of illustration: "Mobility" (33), "Self-management" (44), "Psychological state" (38) and "Circumstances" (29).



Fig. 2 Wordcloud search results from the scoping review on Functional Independence

Adding a Clinical View and Analyzing the Data

Definition of FI

In addition to the preliminary definition of FI based on literature review, stakeholders mentioned the importance to include a safety-component with respect to FI based on their clinical expertise. Furthermore, participants asked for a further specification of 'independent'; it raised questions on the classification of independence when a medical instrument was used. Also the term 'daily functioning' was considered to be liable to personal interpretation. Participants finally agreed on the following definition of FI: "Functioning physically safe and independent from other persons, within one's own context".

The Comprehensive Overview of FI

Elaborating on the definition of FI, stakeholders categorized and prioritized the key terms from the literature that were associated with FI. As a result, three domains considered to be of equal importance to FI: “physical capacity”, “coping” and “context”. Next to these domains, stakeholders suggested adding “empowerment” and “health literacy” as additional factors contributing to FI. Furthermore, stakeholders recommended to operationalize the factor “context” into home environment, social environment and neighborhood. With respect to the sustainability of FI, participants emphasized that FI seems to be a dynamic condition as persons can suddenly become dependent from another person due to for instance a traumatic event but then again regain their independent functioning by recovery or rehabilitation. Finally, FI should be seen as a disease-independent construct, which focusses on the ability of persons to stay independent, apart from disorders or diseases demanding salutogenesis (48). The comprehensive overview of FI is graphically presented in Fig. 3.

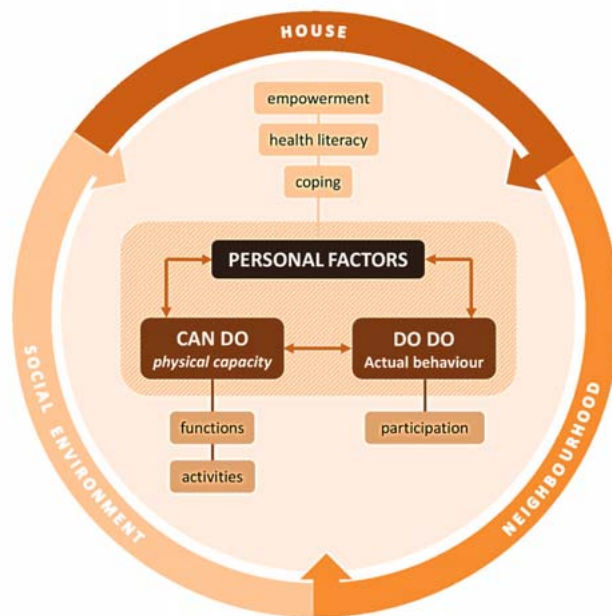


Fig. 3 The graphic presentation shows the contributing factors of Functional Independence

DISCUSSION

This scoping review aimed to determine a clinically relevant definition of FI and an overview of influencing factors of FI in community-dwelling older people. As a result from the literature review and stakeholder consultation, FI could be interpreted as an interplay of physical capacity and behavioral and cognitive factors such as coping, empowerment and health literacy, that enables an older person to function physically safe and independent from other persons, within one's own

context. Therewith, FI could not be seen as a discriminant outcome (functional independent versus functional dependent) but rather as a sliding scale. Someone's level of FI depends on someone's level of physical capacity influenced by personal and environmental factors. One important part of the definition of FI is 'safety'. As prior studies in older adults reported that falls are a major public health issue among community dwelling older adults worldwide (49-51), this study stresses the importance of safety when considering one's FI (16). Second, we have identified personal factors like coping, empowerment and health literacy as relevant to the concept FI. Although insufficient empowerment skills and poor health literacy are not directly associated with a loss of independent functioning they are associated with poorer health outcomes (52,53). In addition coping, empowerment and health literacy interact: poor health literacy causes a lack of empowerment (54).

Results from this study are in agreement with the holistic view on a persons' health related disability's (9,55). It enriches previous views on FI, which focused exclusively on the physical component of FI (56). Although we mentioned physical capacity as one of the most important contributing factors to FI, aligned with other multi-component concepts focusing on independency as the ICF (14) and Integrated Care for Older People (ICOPE) guidelines (57), the graphical presentation shows FI itself should be seen as physical performance being influenced by contextual factors, both personal and environmental factors. Furthermore the identified domains associated with FI are comparable to, for example, the physical literacy statement which also mentions the influence of cognitive and behavioral factors as knowledge and motivation besides physical competence as influencers of maintaining an active lifestyle (58).

Strengths and Limitations

One of the strengths of the current study was the design of the study. The scoping review design combined a literature search with a clinical view of relevant stakeholders, which is particularly suitable to explore a quite new concept like FI. Moreover, development in co-creation with the end users increases the chance of implementation in daily practice (18). The fact that FI was an unrecognized term gave the study a broad explorative character, with a broad search strategy and lacking exclusion criteria. Though, a number of limitations should be mentioned. First, as we did not filter on type of research paper, a significant amount of 'grey' literature was considered for inclusion. Unfortunately, a part of the identified articles were unavailable as full-text articles and consequently should have been excluded. Due to practical restrictions the stakeholder consultation had to be held online instead of in person, this limits the expression of emotions and can emerge misunderstanding. However, this was convenient, participants could provide input at the time which suited best, it made interaction between participants possible while not all persons had to be in a discussion simultaneously. Previous research on independency of community dwelling older people confirms the influence of contextual factors, mentioning spouses as caregivers and environmental obstacles in the home environment and neighborhood (59,60).

Recommendations

This scoping review delivers a clinical and scientifically relevant definition of FI and an overview of factors contributing to FI in older people. This has several implications for clinical practice, health policy, health education and further research. The most important recommendation concerns interprofessionalism as the construct exceeds the border of a single profession and single ICF domain. Maintaining FI asks for a sufficient level of physical capacity, adequate coping, sufficient health literacy and empowerment, adapted to an older adult's context, and, therefore, professionals are recommended to look for interprofessional collaboration when supporting community-dwelling older people. This recommendation suits to current health policy which focuses on providing patient-centered care from a holistic perspective (61-64). As at this moment interprofessional collaboration in the community care is still in its infancy, there is a call for financial investment, theoretical development and practical facilitation of this concept. One of the ways to facilitate interprofessionalism both in an educational setting and clinical setting is developing a generic measurement tool to determine and monitor the level of FI in community dwelling older people.

Conclusion

This scoping review resulted in an interprofessionally supported definition of FI as “Functioning physically safely and independent from another person, within one's own context”. For maintaining functional independent, sufficient physical capacities are needed but also personal and environmental factors like an adequate coping style, empowerment skills and a sufficient level of health literacy. Future research is recommended on operationalizing those factors in measurable quantities to facilitate professionals in community care to determine and monitor older people's FI in a joint manner.

REFERENCES

- 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.* 2017;40(1):19–25. doi:10.1519/JPT.0000000000000142.
- Clark BC, Manini TM. Functional consequences of sarcopenia and dynapenia in the elderly. *Curr Opin Clin Nutr Metab Care.* 2010;13(3):271–6. doi:10.1097/MCO.0b013e328337819e.
- Freedman VA, Martin LG, Schoeni RF. Recent trends in disability and functioning among older adults in the United States: a systematic review. *JAMA.* 2002;288(24):3137–46.
- Curzel J, Forgiarini LA Jr, Rieder MM. Evaluation of functional independence after discharge from the intensive care unit. *Rev Bras Ter Intensiva.* 2013;25(2):93–8. doi:10.5935/0103-507X.20130019.
- Mortenson WB, Demers L, Fuhrer MJ, Bilkey J, Jutai J, Alkadri J, Aziz J. Comparing assessments of physical functional independence in older adults with mobility limitations. *Am J Phys Med Rehabil.* 2018. doi:10.1097/PHM.0000000000001092.
- Angus J, Kontos P, Dyck I, McKeever P, Poland B. The personal significance of home: habitus and the experience of receiving long-term home care. *Sociol Health Illn.* 2005;27(2):161–87.
- Bodenheimer T. High and rising health care costs. Part 3: the role of health care providers. *Ann Intern Med.* 2005;142(12 Pt 1):996–1002.
- Coulter A. Shifting the balance from secondary to primary care. *BMJ.* 1995;311:1447. doi:10.1136/bmj.311.7018.1447.
- Huber M, Knottnerus JA, Green L, van der Horst H, Jadad AR, Kromhout D, et al. How should we define health? *BMJ.* 2011;343:d4163. doi:10.1136/bmj.d4163.
- Edwards LC, Bryant AS, Keegan RJ, Morgan K, Jones AM. Definitions, foundations and associations of physical literacy: a systematic review. *Sports Med.* 2017;47(1):113–26. doi:10.1007/s40279-016-0560-7.
- Glenny C, Stolee P. Comparing the functional independence measure and the interRAI/MDS for use in the functional assessment of older adults: a review of the literature. *BMC Geriatr.* 2009;9:52. doi:10.1186/1471-2318-9-52.
- Mahoney FI, Barthel DW. Functional evaluation: the Barthel index. *Md State Med J.* 1965;14:61–5.
- Wallace M, Shelkey M. Katz index of independence in activities of daily living (ADL). *Urol Nurs.* 2007;27(1):93–4.
- Ustun TB, Chatterji S, Bickenbach J, Kostanjsek N, Schneider M. The international classification of functioning, disability and health: a new tool for understanding disability and health. *Disabil Rehabil.* 2003;25(11–12):565–71. doi:10.1080/0963828031000137063.
- deCarvalho IA, Epping-Jordan J, Beard JR. Integrated care for older people: guidelines on community-level interventions to manage declines in intrinsic capacity. Geneva: World Health Organization; 2018.
- Collins B. Independence: proposing an initial framework for occupational therapy. *Scand J Occup Ther.* 2017;24(6):398–409. doi:10.1080/11038128.2016.1271011.
- Sangaleti C, Schweitzer MC, Peduzzi M, Zoboli EL, Soares CB. Experiences and shared meaning of teamwork and interprofessional collaboration among health care professionals in primary health care settings: a systematic review. *JBI Database System Rev Implement Rep.* 2017;15(11):2723–88. doi:10.111124/JBISRI-2016-003016.
- Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol.* 2005;8(1):19–32. doi:10.1080/1364557032000119616.
- Colquhoun HL, Levac D, O'Brien KK, Straus S, Tricco AC, Perrier L, et al. Scoping reviews: time for clarity in definition, methods, and reporting. *J Clin Epidemiol.* 2014;67(12):1291–304. doi:10.1016/j.jclinepi.2014.03.013.
- Mateen FJ, Oh J, Tergas AI, Bhayani NH, Kamdar BB. Titles versus titles and abstracts for initial screening of articles for systematic reviews. *Clin Epidemiol.* 2013;5:89–95. doi:10.2147/CLEP.S43118.
- Alma MA, Groothoff JW, Melis-Dankers BJ, Post MW, Suurmeijer TP, van der Mei SF. Effects of a multidisciplinary group rehabilitation programme on participation of the visually impaired elderly: a pilot study. *Disabil Rehabil.* 2012;34(20):1677–85. doi:10.3109/09638288.2012.656795.
- Amtmann D, Bamer AM, Cook KF, Askew RL, Noonan VK, Brockway JA. University of Washington self-efficacy scale: a new self-efficacy scale for people with disabilities. *Arch Phys Med Rehabil.* 2012;93(10):1757–65. doi:10.1016/j.apmr.2012.05.001.
- Andresen EM, Malmstrom TK, Miller DK, Miller JP, Wolinsky FD. Retest reliability of self-reported function, self-care, and disease history. *Med Care.*

- 2005;43(1):93–7.
24. Arends RY, Bode C, Taal E, Van de Laar MA. A goal management intervention for polyarthritis patients: rationale and design of a randomized controlled trial. *BMC Musculoskelet Disord.* 2013;14:239. doi:10.1186/1471-2474-14-239.
 25. Ashe MC, Eng JJ, Miller WC, Soon JA. Disparity between physical capacity and participation in seniors with chronic disease. *Med Sci Sports Exerc.* 2007;39(7):1139–46.
 26. Borg C, Hallberg IR, Blomqvist K. Life satisfaction among older people (65+) with reduced self-care capacity: the relationship to social, health and financial aspects. *J Clin Nurs.* 2006;15(5):607–18. doi:10.1111/j.1365-2702.2006.01375.x.
 27. Boyle ES, Sielski KA. Correlates of health locus of control in an older, disabled group. *J Psychol.* 1981;109(1):87–91. doi:10.1080/00223980.1981.9915290.
 28. Buck U, Poole J, Mendelson C. Factors related to self-efficacy in persons with scleroderma. *Musculoskeletal Care.* 2010;8(4):197–203. doi:10.1002/msc.181.
 29. Cardol M, de Jong BA, van den Bos GA, Beelem A, de Groot IJ, de Haan RJ. Beyond disability: perceived participation in people with a chronic disabling condition. *Clin Rehabil.* 2002;16(1):27–35. doi:10.1191/0269215502cr464oa.
 30. Collins B, O'Mahony P. Physically disabled adults' perceptions of personal autonomy: impact on occupational engagement. *OTJR.* 2015;35(3):160–8. doi:10.1177/1539449215575264.
 31. Dirik A, Cavlak U, Akdag B. Identifying the relationship among mental status, functional independence and mobility level in Turkish institutionalized elderly: gender differences. *Arch Gerontol Geriatr.* 2006;42(3):339–50.
 32. Doba N, Tokuda Y, Saiki K, Kushiro T, Hirano M, Matsubara Y, Hinohara S. Assessment of self-efficacy and its relationship with frailty in the elderly. *Intern Med.* 2016;55(19):2785–92. doi:10.2169/internalmedicine.55.6924.
 33. Faul AC, Yankeelov PA, Rowan NL, Gillette P, Nicholas LD, Borders KW, et al. Impact of geriatric assessment and self-management support on community-dwelling older adults with chronic illnesses. *J Gerontol Soc Work.* 2009;52(3):230–49. doi:10.1080/01634370802609288.
 34. Gignac MAM, Cott C, Badley EM. Adaptation to chronic illness and disability and its relationship to perceptions of independence and dependence. *J Gerontol B Psychol Sci Soc Sci.* 2000;55(6):P362–72.
 35. Gronstedt H, Hellstrom K, Bergland A, Helbostad JL, Puggaard L, Andresen M, et al. Functional level, physical activity and wellbeing in nursing home residents in three Nordic countries. *Aging Clin Exp Res.* 2011;23(5–6):413–20. doi:10.3275/7507.
 36. Harrison AL. The influence of pathology, pain, and coping on function among older women with knee osteoarthritis [dissertation]. 2002. Available from: EBSCOhost.
 37. Janke MC, Son JS, Payne LL. Self-regulation and adaptation of leisure activities among adults with arthritis. *Act Adapt Aging.* 2009;33(2):65–80.
 38. Jenkins LS, Gortner SR. Correlates of self-efficacy expectation and prediction of walking behavior in cardiac surgery elders. *Ann Behav Med.* 1998;20(2):99–103.
 39. Marques A, Jacome C, Gabriel R, Figueiredo D. Comprehensive ICF core set for obstructive pulmonary diseases: validation of the activities and participation component through the patient's perspective. *Disabil Rehabil.* 2013;35(20):1686–91. doi:10.3109/09638288.2012.750691.
 40. McAuley E, Konopack JF, Morris KS, Motl RW, Hu L, Doerksen SE, et al. Physical activity and functional limitations in older women: influence of self-efficacy. *J Gerontol B Psychol Sci Soc Sci.* 2006;61(5):P270–7.
 41. McAuley E, Morris KS, Doerksen SE, Motl RW, Liang H, White SM, et al. Effects of change in physical activity on physical function limitations in older women: mediating roles of physical function performance and self-efficacy. *J Am Geriatr Soc.* 2007;55(12):1967–73.
 42. Overbeek A, Rietjens JAC, Jabbarian LJ, Severijnen J, Swart SJ, van der Heide A, Korfage IJ. Low patient activation levels in frail older adults: a cross-sectional study. *BMC Geriatr.* 2018;18(1):7. doi:10.1186/s12877-017-0696-9.
 43. Richardson J, Letts L, Chan D, Officer A, Wojtkowski S, Oliver D, et al. Monitoring physical functioning as the sixth vital sign: evaluating patient and practice engagement in chronic illness care in a primary care setting—a quasi-experimental design. *BMC Fam Pract.* 2012;13:29. doi:10.1186/1471-2296-13-29.
 44. Lee WJ, Chen LK, Peng LN, Chiou ST, Chou P. Personal mastery attenuates the adverse effect of frailty on declines in physical function of older people: a 6-year population-based cohort study. *Medicine.* 2016;95(34):e4661.
 45. Corbin JM, Strauss A. Grounded theory research: procedures, canons, and evaluative criteria. *Qual*

- Sociol. 1990;13(1):3–21. doi:10.1007/BF00988593.
46. de Brún T, O'Reilly-de Brún M, Van Weel-Baumgarten E, Burns N, Dowrick C, Lionis C, et al. Using participatory learning & action (PLA) research techniques for inter-stakeholder dialogue in primary healthcare: an analysis of stakeholders' experiences. *Res Involv Engagem*. 2017;3(1):28. doi:10.1186/s40900-017-0077-8.
 47. Mukherjee N. Participatory learning and action: with 100 field methods. New Delhi: Concept Publishing Company; 2002.
 48. Mittelmark MB, Bull T. The salutogenic model of health in health promotion research. *Glob Health Promot*. 2013;20(2):30–8. doi:10.1177/1757975913486684.
 49. Hartholt KA, Polinder S, van der Cammen TJ, Panneman MJ, van der Velde N, van Lieshout EM, et al. Costs of falls in an ageing population: a nationwide study from the Netherlands (2007–2009). *Injury*. 2012;43(7):1199–203. doi:10.1016/j.injury.2012.03.033.
 50. Kannus P, Parkkari J, Koskinen S, Niemi S, Palvanen M, Järvinen M, et al. Fall-induced injuries and deaths among older adults. *JAMA*. 1999;281(20):1895–9. doi:10.1001/jama.281.20.1895.
 51. Marks R, Allegrante JP. Falls-prevention programs for older ambulatory community dwellers: from public health research to health promotion policy. *Soz Präventivmed*. 2004;49(3):171–8.
 52. Berkman ND, Sheridan SL, Donahue KE, Halpern DJ, Crotty K. Low health literacy and health outcomes: an updated systematic review. *Ann Intern Med*. 2011;155(2):97–107. doi:10.7326/0003-4819-155-2-201107190-00005.
 53. Wolf MS, Gazmararian JA, Baker DW. Health literacy and functional health status among older adults. *Arch Intern Med*. 2005;165(17):1946–52. doi:10.1001/archinte.165.17.1946.
 54. Edwards M, Wood F, Davies M, Edwards A. The development of health literacy in patients with a long-term health condition: the health literacy pathway model. *BMC Public Health*. 2012;12:130. doi:10.1186/1471-2458-12-130.
 55. Jette AM. Toward a common language for function, disability, and health. *Phys Ther*. 2006;86(5):726–34. doi:10.1093/ptj/86.5.726.
 56. Lamb SE, Keene DJ. Measuring physical capacity and performance in older people. *Best Pract Res Clin Rheumatol*. 2017;31(2):243–54.
 57. Briggs AM, de Carvalho IA. Actions required to implement integrated care for older people in the community using the World Health Organization's ICOPE approach: a global Delphi consensus study. *PLoS One*. 2018;13(10):e0205533. doi:10.1371/journal.pone.0205533.
 58. Tremblay MS, Costas-Bradstreet C, Barnes JD, Bartlett B, Dampier D, Lalonde C, et al. Canada's physical literacy consensus statement: process and outcome. *BMC Public Health*. 2018;18(Suppl 2):1034. doi:10.1186/s12889-018-5903-x.
 59. Baker MW. Creation of a model of independence for community-dwelling elders in the United States. *Nurs Res*. 2005;54(5):288–95.
 60. Stoller EP, Earl LL. Help with activities of everyday life: sources of support for the noninstitutionalized elderly. *Gerontologist*. 1983;23(1):64–70. doi:10.1093/geront/23.1.64.
 61. Cieza A, Ewert T, Ustun B, Chatterji S, Kostanjsek N, Stucki G. Development of ICF core sets for patients with chronic conditions. *J Rehabil Med*. 2004;(44 Suppl):9–11.
 62. Gobbens R, van Assen M. Associations between multidimensional frailty and quality of life among Dutch older people. *Arch Gerontol Geriatr*. 2017;73:69–76. doi:10.1016/j.archger.2017.07.007.
 63. Liu JY. The severity and associated factors of participation restriction among community-dwelling frail older people: an application of the International Classification of Functioning, Disability and Health (WHO-ICF). *BMC Geriatr*. 2017;17(1):43. doi:10.1186/s12877-017-0422-7.
 64. Tomey KM, Sowers MR. Assessment of physical functioning: a conceptual model encompassing environmental factors and individual compensation strategies. *Phys Ther*. 2009;89(7):705–14. doi:10.2522/ptj.20080213.

Chapter 3

Discriminative Validity of the Core Outcome Set Functional Independence in a Population of Older Adults

Yvonne Dockx, Esther Molenaar, Di-Janne Barten, Cindy Veenhof

BMC Geriatrics. 2020; 20: 309

DOI: 10.1186/s12877-020-01705-6

ABSTRACT

Background: Clinicians are currently challenged to support older adults to maintain a certain level of Functional Independence (FI). FI is defined as “functioning physically safely and independent from another person, within one’s own context”. A Core Outcome Set was developed to measure FI. The purpose of this study was to assess discriminative validity of the Core Outcome Set FI (COSFI) in a population of Dutch older adults (≥ 65 years) with different levels of FI. Secondary objective was to assess to what extent the underlying domains ‘coping’, ‘empowerment’ and ‘health literacy’ contribute to the COSFI in addition to the domain ‘physical capacity’.

Methods: A population of 200 community-dwelling older adults and older adults living in residential care facilities were evaluated by the COSFI. The COSFI contains measurements on the four domains of FI: physical capacity, coping, empowerment and health literacy. In line with the COSMIN Study Design checklist for Patient-reported outcome measurement instruments, predefined hypotheses regarding prediction accuracy and differences between three subgroups of FI were tested. Testing included ordinal logistic regression analysis, with main outcome prediction accuracy of the COSFI on a proxy indicator for FI.

Results: Overall, the prediction accuracy of the COSFI was 68%. For older adults living at home and depending on help in (i)ADL, prediction accuracy was 58%. 60% of the preset hypotheses were confirmed. Only physical capacity measured with Short Physical Performance Battery was significantly associated with group membership. Adding health literacy with coping or empowerment to a model with physical capacity improved the model significantly ($p < 0.01$).

Conclusions: The current composition of the COSFI, did not yet meet the COSMIN criteria for discriminative validity. However, with some adjustments, the COSFI potentially becomes a valuable instrument for clinical practice. Context-related factors, like the presence of a spouse, also may be a determining factor in this population. It is recommended to include context-related factors in further research on determining FI in subgroups of older people.

Keywords: Functional Independence · Core outcome set · Elderly · Validity

BACKGROUND

When physical limitations increase, participating in activities of daily living becomes harder and living safely in the own home environment becomes challenging [1]. Problems in physical functioning potentially cause diminished self-sufficiency, loss of independence, and reduced quality of life [2]. Given the ageing society, which is commonly associated with an increase in physical limitations, one of the goals of the present healthcare system is to facilitate self-sufficiency and independent living as long as possible [3]. This is obviously reflected in clinical practice: clinicians are currently challenged to support older people in maintaining their 'Functional Independence' [4, 5]. Previous studies on FI mainly focused on physical aspects when referring to FI (Molenaar et al. 2019, under review). However, 'independence' is a complex construct on itself, which certainly exceeds the physical domain. Baltes described the concept of 'behavioral induced dependency' in which environmental circumstances and especially social interactions are determinative for independent functioning [6]. There are several mechanisms explaining the development of dependent behaviors, assuming a learned dependency influenced by behaviors of caregivers. This implies independence in daily activities cannot be seen apart of independency of other people. A recent scoping review combining a literature review with expert consultations in the field of (community) care for older adults, confirmed the assumed wider look on the construct of FI, especially regarding the importance of older people's context. In addition to the relevance of their social context, experts in the field of community care stressed the relevance of a safe home environment and neighborhood.

Furthermore, literature suggests that coping style, health literacy and empowerment skills influence the level of FI in older people besides physical capacity [7–10]. Thus, physical, physiological and social aspects jointly represent the complex construct of FI. As a result, FI could be seen as a complex interaction between physical, psychological and social aspects respecting one's home environment, social environment and neighborhood (Molenaar et al. 2019, under review). FI is defined as the ability of people to function physically safe and independent from another person, within their own context (Fig. 1) (Molenaar et al. 2019 under review).

A difference is expected in level of FI between people living in the community with and without support in daily activities and people living in a residential care facility. The main reason for admission to a residential care facility is the presence of substantial limitations in activities of daily living [3]. These are influenced by multi-morbidity, physical impairments, a low sense of self-management, and diminished social support [3]. A substantial part of this influencing factors is related to the concept of FI.

FI often exceed the borders of one specific profession; understanding, operationalizing and maintaining FI in older people calls for collaboration between various clinical expertises and underlying knowledge areas. To facilitate clinicians in adhering an unambiguous approach with respect to maintenance of FI in older adults, clinicians would increasingly benefit from an easy to use, interprofessionally interpretable instrument which supports them in precisely determining someone's level of FI. An instrument to objectify FI has recently been developed in a population of older adults: the Core Outcome Set Functional Independence (Molenaar et al. 2019, in progress). This Core Outcome Set

theoretically comprises each of the domains of FI and is designed to assist clinicians in identifying, monitoring and supporting older adults who have (or are at risk for) limitations in FI. To enable clinicians to use the Core Outcome Set FI (COSFI) in clinical practice, the psychometric properties of the COSFI need to be assessed [11].

METHODS

Aim

The primary objective of this study was to assess the discriminative validity of the COSFI in a population of Dutch, older adults (≥ 65 years of age) with different levels of FI. The secondary aim was to assess to what extent the non-physical related domains of the FI construct (coping, empowerment and health literacy) contributed to the classification in different levels of FI by the COSFI in addition to the domain 'physical capacity' in a population of Dutch older adults (≥ 65 years of age).

Study design

This study was a cross-sectional validation study.

Population and setting

Participants were community-dwelling older adults as well as older adults, living in residential care facilities in the Netherlands. Data were collected from February until May 2019. Identification of eligible older adults was done by district nurses and physical therapists. Also, recruitment took place by inviting older adults to participate through local newspapers and social media. Older adults could be included if they were 65 years or over and were able to understand verbal and written instructions in Dutch. Older adults with severe cognitive impairments which hindered completing the questionnaires, were excluded.

Study procedure

Older adults were asked to come to a local test location or were offered a home visit to complete the measurements consisting of physical examinations and questionnaires. After giving written informed consent, they were guided through the approximately 60-min test-procedure. Physical examinations were conducted by trained researchers and students with different (clinical) expertise and background, for example physical therapy, occupational therapy and human movement sciences. Participants could complete the questionnaires themselves but were offered help from a member of the research team when needed. The test-procedure included (1) the measurements of the COSFI, (2) measurement of reference variable 'membership of subgroup representing level of independence in daily living' to validate the Core Outcome Set, and (3) a general questionnaire for demographic characteristics. The following section contains a description of the Core Outcome Set.

Measurements of the Core outcome set functional Independence

As no single instrument covered the total construct of FI, the COSFI was recently developed following recommendations from the Guideline for Selecting Outcome Measurement Instruments for Outcomes included in a Core Outcome Set [12]. The choice of specific measurement tools was determined by clinimetric properties of existing instruments representing the domains, their usability in the home-environment, availability in Dutch and multiple consensus meetings of the research group. Adjustments were made after pilot testing, based on the experiences of the researchers and the older adults who were tested. The COSFI contains four domains:

Physical capacity

Physical capacity was defined as the composite of all the physical capacities a person can draw on (generally described in terms of body system functions such as strength, balance) [13]. Physical capacity was measured by four physical tests. The Short Physical Performance Battery (SPPB) is recommended to assess physical capacity in older adults [14, 15]. The SPPB consists of three subscales: balance, gait speed and lower extremity strength [14, 15]. To test static balance more extensively, the Frailty and Injuries Cooperative Studies of Intervention Techniques (FICSIT-study) measurement instrument FICSIT-4 was added to the SPPB. It measures the ability to maintain balance over a diminishing base of support [16]. Because dynamic balance during walking is also an important component of physical capacity [17], the Timed Up and Go test (TUG) was added to the measurements. The TUG measures the time needed to stand up from a chair, walk three meters, turn, walk back and sit down. Furthermore, hand grip strength was measured three times for each hand with a JAMAR hand-held dynamometer, because this reflects overall muscle strength in older adults [18]. The maximum value in kilograms was administered [19].

Coping

For coping the Coping Flexibility questionnaire (COFLEX) was used, based on the following definition of the domain: Ability of the individual to use both assimilative and accommodative coping strategies to deal with stressors in different situations (versatility and reflective coping) [20]. While using assimilative coping strategies a person actively influences his or her situation to reach personal goals. With accommodative coping strategies personal goals are tailored to restrictions of a given situation. The versatility scale measures the ability to switch between assimilative and accommodative coping strategies, depending on personal goals and environmental circumstances. The reflective coping scale measures the ability to choose a coping strategy that fits the circumstances. This results in two scores, one for each aspect. Both scales provide a number of statements with four answer possibilities: seldom or never, sometimes, often, almost always [20]. These correspond with scores of respectively one to four. The total scale-score is the sum of scores on that scale and a higher score indicates better coping skills. For versatility an example of a statement is 'I can easily change my approach if necessary' and for reflective coping 'I question myself whether my approach to the problem is the best solution'.

Empowerment

Empowerment was seen as the discovery and development of one's inherent capacity to be responsible for one's own life [21]. People are empowered when they have sufficient knowledge to make rational decisions, sufficient control and resources to implement their decisions, and sufficient experience to evaluate the effectiveness of their decisions [21]. The Patient Activation Measure (PAM) is recommended to measure the concept of empowerment [22]. The PAM-13 consists of thirteen statements, for example 'I am confident that I can take actions that will help prevent or minimize some symptoms or problems associated with my health condition'. These are scored on a four-point Likert scale ranging from 'totally disagree' to 'totally agree' and 'non applicable'. Based on this an activation score is computed between 0 (no activation) and 100 (high activation). On this continuum four levels of patient activation can be distinguished [23]. These levels are 'disengaged and overwhelmed', 'becoming aware, but still struggling', 'taking action and gaining control', 'maintaining behaviors and pushing further'.

Health literacy

Health literacy was defined as people's knowledge, motivation and competences to access, understand, appraise and apply health information [24]. This enables them to make judgements and take decisions in everyday life concerning healthcare, disease prevention and health promotion to maintain or improve quality of life during the life course. The Newest Vital Sign (NVS-D) is a six-question tool to assess one's level of health literacy by determining an individual's ability to find and interpret information on an ice-cream nutrition label [25]. One of the questions asks people to calculate how many ice-cream they can eat when there is a restriction on intake of calories. For each right answer one point is administered, resulting in a score between zero and six. Cut-off point for adequate health literacy is a score of four or more.

Clinimetric properties of the included measurement instruments are described in Table 1.

Table 1 Clinimetric properties Core Outcome Set Functional Independence

Domain	Instrument	Target population	Clinimetric properties
Physical capacity	SPPB	Older adults ¹²	Predictive for developing disability and identifies subgroups who have high and low risk of disability (AUC .75). ^{12,24} Cut-off points are scores of four and nine. ²⁵ Good intrarater reliability (ICC .88 - .92) and high construct and concurrent validity. ¹²
	FICSIT-4	Older adults ¹⁴	Moderate to good reliability (Interclass Pearson correlations .25 to .74). ¹⁴ Good concurrent validity. ¹⁴
	TUG	People with hip and knee osteoarthritis, patients with stroke and older adults with dementia ^{26,27}	Good reliability (ICC .75 to .99). ^{26,27} Good construct and convergent validity. ^{26,28} The cut-off point for independent walking is 20 seconds. ²⁹ When it is impossible to complete the TUG, a fictive score of 240 seconds is registered. ²⁹
	JAMAR	General population and community-dwelling older adults ^{30,31}	Excellent intra- and interrater reliability (ICC .98 and .94). ³⁰ Good test-retest reliability (ICC .91 for right and .95 for left hand). ³¹ MCID is 6.5 kilogram. ³²
Coping	COFLEX	Patients with chronic rheumatoid arthritis ¹⁸	Acceptable internal consistency (Cronbach's α of respectively .88 and .70 for the subscales). ¹⁸ Construct validity good for the versatility scale. ¹⁸
Empowerment	PAM-13	Older adults and older adults with multimorbidity	Good internal consistency (Cronbach's α of .88). ^{21,33} Good construct validity. ^{33,34}
Health literacy	NVS-D	Older adults	Good internal consistency (Cronbach's α of .76). ²³ Cut-off point between adequate and inadequate health literacy is a score of four or more. ²³

SPPB Short Physical Performance Battery; FICSIT Frailty and Injuries Cooperative Studies of Intervention Techniques; TUG Timed Up and Go test; COFLEX Coping Flexibility questionnaire; PAM Patient Activation Measure; NVS-D Dutch Newest Vital Sign; AUC Area Under the Curve; ICC Intraclass Correlation Coefficient; MCID Minimal Clinically Important Difference

Outcome

Discriminative validity of the COSFI was determined following the COSMIN Study Design checklist for Patient-reported outcome measurement instruments [37]. Respecting this checklist, discriminative validity of the COSFI implies the degree to which the scores on the COSFI are consistent with hypotheses with regard to differences between relevant subgroups, based on the assumption that the COSFI validly measures the construct of FI [38]. With 75% of hypotheses reached, discriminative validity would be considered as confirmed [39]. In this study, three distinctive subgroups were compared which differed in level of independence in daily living: community-dwelling older adults independent in (i)ADL, community-dwelling older adults, dependent on help of others in (i)ADL and older adults living in a residential care facility (Fig. 1). The subgroups were composed by way of a proxy indicator, based on two conditions. First, as the definition of FI includes 'independent from another person', help needed in (instrumental) activities of daily living ((i)ADL) was included in the proxy indicator.

This was determined by the Groningen Activity Restriction Scale (GARS-3), since GARS3 showed adequate discriminative validity in a population of older adults [40]. This eighteen item questionnaire gives an indication of disabilities in the domains of personal care and domestic activities by registering if a person can do activities in three categories: fully independently with no effort (score one), fully independently with effort (score two) or only with help of others (score three) [40]. Any score on the GARS-3 other than 'fully independently' represented a diminished level of independency [40]. Second, as the definition of FI includes 'functioning physically safe, within the own context', living situation was part of the proxy indicator. When not functioning physically safe, falls are more likely to occur. Falls are a strong predictor for dependence in ADL-activities and for admission to a residential care facility [41–43]. A difference was made between living in the community (own context) and living in a residential care facility.

The following hypotheses were set regarding COSFI scores in relation to the distinctive subgroups of independence:

1. The model based on the COSFI correctly classifies at least 70% of the participants for each of the three subgroups.
2. There is a significant difference between groups on all domains of the COSFI with best scores for the group of older adults living in the community without help in (i)ADL and worst scores for the group of older adults living in a residential care facility.
3. Meaningful differences between these groups were expected on the scores of the measurement instruments in the physical domain of the COSFI, since it is known there is a difference in the amount of physical limitations between older adults living in their own environment and older adults living in a residential care facility [3]. For SPPB older adults living in their own environment were expected to score above the cut-off point of 9 and older adults living in a residential care facility below. For TUG older adults living in their own environment were expected to score below the cut-off point of 20 s and older adults living in a residential care facility above. For JAMAR a difference of at least 6.5 kg was expected between older adults living in their own environment and older adults living in a residential care facility.
4. A meaningful difference, reflected by a different level of patient activation on the PAM, was expected on the domain of empowerment between older adults living in their own environment and older adults living in a residential care facility. It is known that a low sense of self-management is related to admission to a residential care facility [3] and the concept of self-management is part of the definition of empowerment.
5. It was expected that the level of health literacy would be highest in the group of older adults, living in their own environment and independent of others (on or above the cut-off score of 4) and lowest

in the group of older adults living in a residential care facility (below the cut-off score of 4), because literature shows people with lower health literacy skills show poorer overall health status [44].

Statistical analyses

Descriptive statistical analyses were conducted on participant's age, gender, educational level, presence of morbidities and type of residence. Demographic characteristics and scores on the Core Outcome Set were calculated by mean and standard deviation or median and interquartile range for continuous variables and proportions for categorical variables. To test the formulated hypotheses determining discriminative validity of the COSFI several statistic techniques were used. The ability of the COSFI to predict the level of FI for three different subgroups was determined using ordinal logistic regression. First, the assumptions for logistic regression were tested. After that a model was built with group membership as dependent variable. All scores of the COSFI were entered as predictor variables in the ordinal regression model using 'forced entry terms'. Based on the rule of thumb of ten events per variable for logistic regression analysis and eight included variables, a sample size of a minimum of 80 people in each group was optimal [45]. Differences between groups were calculated by Oneway ANOVA for normally distributed continuous variables, Kruskal-Wallis for not normally distributed variables and Chi-square test for categorical variables. To meet the second objective of the study, likelihood statistics of subsequently a null-model, a model with only physical capacity (SPPB, JAMAR) and models with physical capacity and respectively coping (COFLEX versatility, COFLEX reflective coping), empowerment (PAM) or health literacy (NVS-D) were tested for improvement of the model. Forward, stepwise ordinal regression analysis was applied, using a likelihood ratio (LR) test (X2 test) to determine to best fit. P-value < 0.05 was considered significant. When missing values occurred in the dependent or one of the predictor variables, these cases were excluded from the analysis. Statistical analyses were performed using IBM Statistical Package for the Social Sciences (SPSS, version 24,0 Armork, New York, USA).

RESULTS

Population

In total, 200 older adults were recruited to participate in this study. Eight persons were excluded because of severe cognitive impairments. One person living alone in the community, did not complete the GARS questionnaire and therefore, could not be included in one of the groups. Thirteen older adults had missing values on predictor variables and were excluded from the analyses. Finally, a total of 178 persons were included for analyses. Demographic characteristics are presented in Table 2. Sixty-six persons lived independently without help in activities of daily living. In the second group, independently living older adults who were dependent on help in at least some daily activities, sixty-nine persons were included. Forty-three older adults living in a residential care facility became the third group. Mean age was 80.2 years. Age significantly differed between the three groups. Independently living people without help had significantly fewer medical conditions, compared to the other groups. Gender and educational level did not differ between groups.

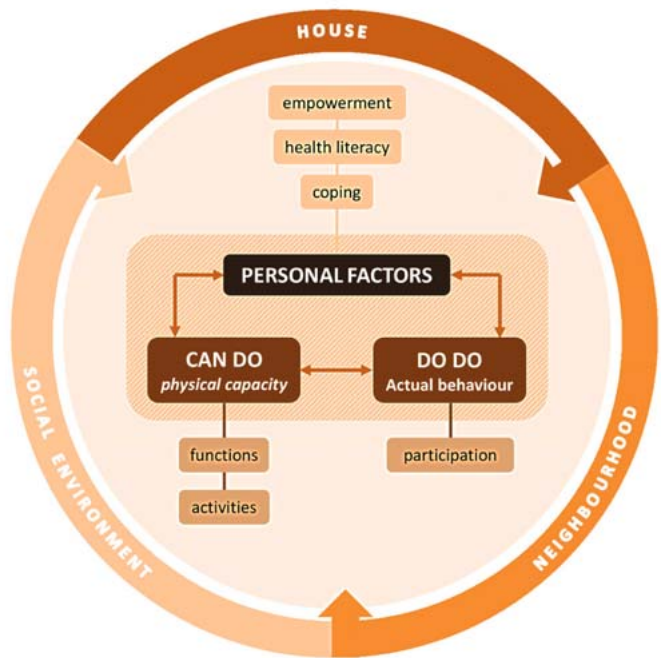


Fig. 1 Graphical illustration of the concept of Functional Independence

Table 2 Demographic characteristics of older adults measured for Functional Independence

Participant Characteristic	Total n = 178	Independent living No help with (i) ADL n = 66	Independent living Help with (i)ADL n = 69	Living in residential care facility n = 43
Age in years at study participation (mean, sd)	80.19 (8.05)	76.50 (6.40)*	80.77 (7.30)*	84.93 (8.85)*
Gender (n, %)				
male	72 40.4	32 48.5	26 37.7	14 32.6
female	106 59.6	34 51.5	43 62.3	29 67.4
Educational level (n, %)				
none	1 0.6	1 1.5	0 0.0	0 0.0
primary	121 68.0	42 63.3	47 68.2	32 74.4
secondary	38 21.3	15 22.7	13 18.8	10 23.3
tertiary	18 10.1	8 12.1	9 13.0	1 2.3
Type of residence in case of living in the community (n,%)				
alone	80 59.3	39 59.1	41 59.4	na
with other(s)	55 40.7	27 40.9	28 40.6	na
No. of medical conditions (n, %)				
none	12 6.7	9*,† 13.6	2* 2.9	1† 2.3
one or two	73 41.1	38*,† 57.6	23* 33.3	12† 27.9
three or more	93 52.2	19*,† 28.8	44* 63.8	30† 69.8

(i)ADL (instrumental) activities of daily living; n number of participants; sd standard deviation; no. number; % = percentage; *,† = significant difference between groups $p < 0.05$

Discriminative validity Core outcome set functional Independence

While testing the assumptions for ordinal logistic regression, the FICSIT-4 was excluded from the analysis due to multicollinearity. The TUG was also excluded from analyses, as fictitious scores of 240 s were assigned to people who were unable to perform the test. This resulted in unjustified outliers. All remaining measurement instruments of the COSFI were included as predictor variables. Only physical

capacity measured with the SPPB was significantly associated with group membership. The odds of classification into the group of community-dwelling older adults depending on help instead of the group of independent community-dwelling older adults and of classification into the group of older adults living in a residential care facility instead of community-dwelling older adults depending on help increased by a factor 1.64 for each point decline on the SPPB (Table 3). Table 4 shows that this final model was able to correctly classify 68% of the participants into one of the predefined groups. In the group of independently living older adults without help and the group of older adults living in a residential care facility more than 70% was classified correctly. A percentage of 58% correctly classified is shown in the older adults living at home, needing help with (i)ADL. As we did not reach a 70% prediction accuracy for all three groups, hypothesis 1 was rejected. Results on instruments of the Core Outcome Set are presented in Table 5, both for the total sample as well as for the different subgroups. Significant differences between all three groups were found on all instruments for physical capacity and health literacy. For COFLEX Versatility and PAM-13 a significant difference was found between both groups living independently and the group living in a residential care facility. This confirmed hypothesis 2 about significant differences between subgroups on all domains (Table 5).

Table 3 Ordinal logistic regression prediction on group membership Functional Independence

	Wald	p	OR	95% CI
Physical capacity				
<i>SPPB</i>	49.909	0.000	1.64	1.43 - 1.88
<i>JAMAR</i>	3.377	0.066	1.03	1.00 - 1.06
Coping				
<i>COFLEX versatility</i>	0.989	0.320	1.04	0.96 - 1.12
<i>COFLEX reflective coping</i>	0.000	0.983	1.00	0.88 - 1.14
Empowerment				
<i>PAM</i>	0.246	0.620	0.99	0.97 - 1.02
Health literacy				
<i>NVS-D</i>	2.619	0.106	1.03	0.97 - 1.36

Wald = Wald statistic; p = p-value; OR = Odds Ratio; CI = Confidence Interval; SPPB = Short Physical Performance Battery; TUG = Timed Up and Go test; COFLEX = Coping Flexibility questionnaire; PAM = Patient Activity Measure; NVS-D = Dutch Newest Vital Sign

Table 4 Prediction accuracy of the model based on the Core Outcome Set

Observed	Independent living; no help with (i)ADL (n)	Independent living; help with (i)ADL (n)	Living in residential care facility (n)	% correct
Independent living; no help with (i)ADL (n)	48	18	0	73%
Independent living; help with (i)ADL (n)	18	40	11	58%
Living in residential care facility	2	9	32	74%
Overall percentage	38%	38%	24%	68%

i)ADL (instrumental) Activities of Daily Living

Table 5 Scores of older adults on the Core Outcome Set Functional Independence

Measurement instrument	Total	Independent living No help with (I)ADL	Independent living Help with (I)ADL	Living in residential care facility
n	178	66	69	43
Physical Capacity				
SPPB (median, IQR)	9 (6)	10.5 (3)*	8 (5)*	3 (4)*
FICSIT-4 (median, IQR)	18 (13)	23 (6)*	18 (10)*	5 (11)*
TUG (median, IQR)‡	10.19 (6.76)	8.50 (3.08)*	10.71 (5.53)*	22.43 (14.19)*
not able to perform TUG (n)	10	0	3	7
JAMAR (median, IQR)	28 (16.25)	30 (12.5)*	27 (13.5)*	18 (11)*
Coping				
COFLEX Versatility (median, IQR)	26 (8)	28 (9)*	26 (8)†	24 (7)*,†
COFLEX Reflective coping (median, IQR)	11 (4)	11.5 (3)	12 (4)	10 (4)
Empowerment				
PAM-13 (median, IQR)	63.1 (21.8)	67.8 (21.8)*	65.5 (18.2)†	58.1 (16.6)*,†
Health Literacy				
NVS-D (median, IQR)	2 (3)	4 (4)*	2 (4)*	1 (2)*

n = number of participants; (I)ADL = (instrumental) activities of daily living; SPPB = Short Physical Performance Battery; TUG = Timed Up and Go test; COFLEX = Coping Flexibility questionnaire; PAM = Patient Activation Measure; NVS-D = Dutch Newest Vital Sign; IQR = interquartile range; sd = standard deviation; *,† = significant difference between groups p < 0.05; ‡ Median, IQR for group who completed TUG measurement

Finally, meaningful differences on the different measurement instruments were evaluated regarding the preset hypotheses. For SPPB, TUG and JAMAR in the domain of physical capacity, hypothesis 3 was confirmed. On the PAM all three groups showed the same level of patient activation, meaning hypothesis 4 was rejected. On NVS-D older adults living at home and independent from others scored highest (4) and older adults living in a residential care facility scored lowest (1), which confirmed hypothesis 5. Overall 60% of our hypotheses were confirmed.

Contribution of domains coping, empowerment and health literacy to the model

To meet the secondary objective of this study, the additional value of non-physical related domains to the FI-construct were investigated by model building. The best fitting model compared to a model with only physical capacity, was a model with health-literacy (LR 17.240; df 1) and coping (LR 21.736; df 2) or empowerment (LR 20.962; df 1) ($p \leq 0.01$). Adding both empowerment and coping instead of only empowerment or coping did not show a significant difference. (See Additional file 1).

DISCUSSION

The aim of this study was to determine discriminative validity of the COSFI in a population of older adults. With 60% of the hypotheses confirmed, discriminative validity of the COSFI did not meet the COSMIN criteria yet. However, the model based on the COSFI had an overall prediction accuracy of 68%, which is fairly good. Independently living older adults who did not need help in (i)ADL-activities and older adults living in a residential care facility are even better distinguished by the COSFI (73% respectively 74%). The model performed less in the group of older adults living at home and dependent on help, despite the fact that significant differences between groups were shown on most variables. In this group the prediction accuracy was just 58%. This means the model has insufficient ability to distinguish between people living at home with help of others and people living at home completely independently or people living in a residential care facility.

The difference in prediction accuracy between groups can be explained by several reasons. First, the group of older adults living at home, dependent on help, represents a broad range of FI. In this category the dependency on help varied from just periodical help from a pedicure to almost complete help in all (i)ADL activities. Second, the role of an informal caregiver might have influenced the relationship between the COSFI and our proxy. People living at home and dependent on help were often supported by an informal caregiver. This informal caregiver, for instance a spouse, enables older people to maintain living in their home setting instead of being institutionalized. Thus, some people in the group of independently living older adults with help seem to function at a comparable level as people in one of the other groups [46]. Involvement of an informal care giver might be a precondition for living at home instead of in an assisted living facility.

Our study revealed that FI is mostly determined by physical capacity, measured with the SPPB. This is in line with existing knowledge on the relationship between independent functioning and physical capacity [13, 27, 47]. However, this study adds that other domains also contribute to the construct of

FI. Based on the current composite of measurements, a model with physical capacity, coping and one of the domains health literacy or empowerment performed equally good as a model with all domains. This implies that one of the domains health literacy or empowerment can be removed from the COSFI without losing discriminative value. Despite the fact that the NVS-D did not show to be a discriminative factor in distinguishing someone's level of FI, differences in health literacy levels between groups were both significant and clinically relevant [25]. Health literacy is known to be associated with age, physical activity and participating in social activities [48, 49]. In line with these results from earlier studies, the oldest group in this study showed the lowest health literacy skills. On empowerment, no clinically relevant differences between groups were found [50]. All scores belonged to the same level of patient activation and measurement of empowerment did not contribute significantly to a model with all other domains. Therefore, a final model including physical capacity, health literacy and coping seems to perform optimally. The hypothesis about meaningful differences between subgroups on the domain empowerment was not confirmed. However, this hypothesis seems no longer relevant, as the domain empowerment does not significantly contribute to the best fitting model. For the remaining hypotheses 75% was confirmed, indicating good discriminative validity of the COSFI without PAM.

Some strengths of this study could be mentioned. It was the first study which measured a multidimensional concept of FI in older adults. Prior studies were limited to only the physical aspect of FI. Moreover, since the COSFI is intended for interprofessional use in clinical practice, another strength of this study was the cooperation of professionals and students from different backgrounds in the measurement procedure. Third, to determine discriminative validity, older adults with a broad range in levels of physical functioning were measured. This was an adequate representation of the Dutch population of older adults [3]. Finally, the limited amount of missing data could be indicated as a strength of this study.

There were some limitations as well. First, we insufficiently took into account the gradually decline of the level of FI. Currently, we only determined strict cut-off points for the proxy of FI. These cut-off points divided the older adults in three groups, representing a different level of FI. As previously mentioned, the middle group represented a broad range of levels of physical functioning, varying from almost no help to almost complete help in (i)ADL. With a good prediction accuracy for the other groups, the model shows ability to distinguish between older adults with different levels of FI, provided that differences are large enough. Another limitation concerns the influence of environmental factors on one's FI. Literature shows an association between social support and home or social participation, which is closely linked to the definition of FI [51, 52]. In particular the presence of an informal caregiver or another person who provides social support is key for living at home respectively living necessarily in a residential care facility [3, 53]. The amount of social participation and the diversity in social relations influence decline in functional ability, measured on items like walking outside and walking stairs [52]. Although these items were to some extent objectified by the GARS-3, the involvement of (informal) caregivers was insufficiently determined.

Dependency can be caused by several mechanisms, involving the social environment and interventions aiming to reduce dependency should acknowledge this [6]. The behaviors of caregivers are essential to enhance or decline independency in older adults. (Informal) caregivers can cause dependency by underestimating what an older adult can do and provide overcare or they can support independency by adjusting their behavior to the needs and possibilities of the older adult. In other cases, older adults choose for compensation and selection of activities by themselves. In that case, they are able to complete activities, but focus on goals and activities with high priority, asking for help in activities with low priority and as a result become dependent on others. In this study, only the activities which older adults were able to do were measured and not the activities they were actually performing in daily life. Third, although patient reported outcome measures (PROMs) were the only feasible option to measure coping, empowerment and help needed in (i)ADL, the use of PROMs is accompanied by some limitations. PROMs provide subjective data and the outcome is influenced by how the participant perceives his or her situation [54]. The perceived level of coping, empowerment or help needed may not reflect the actual behavior of the participant. Also, these questionnaires were not feasible for older adults with severe cognitive impairments. Therefore, older adults with limitations in their cognitive functioning were excluded from this study. Finally, with 178 participants optimal sample size was not obtained. The difference between actual and optimal sample size is small and probably did not have large impact on the results, because the smallest group is still distinctive.

Prior to implementation in clinical practice, it is recommended to revise the COSFI to some extent. Based on our results, the FICSIT-4 can be removed from the Core Outcome Set because its' high correlation with the SPPB. Despite significant differences between groups, the TUG was not included in the analysis. Because a relatively large group participants was not able to perform the TUG, another instrument to measure dynamic balance possibly would have been more appropriate. As dynamic balance control is an important component of physical capacity and an indicator for risk of falls, this seems relevant to measure additionally to the SPPB. For instance, the Floor Transfer Test may be a good alternative for TUG as well as SPPB, because of high correlation with both instruments [55]. Besides that, it is recommended to remove the PAM from the COSFI. Without the PAM, a large part of the definition of empowerment is still covered in this model as the PAM did not measure all aspects of empowerment. Empowerment aspects were also represented by the NVS-D and COFLEX, because the constructs of health literacy and coping are associated with empowerment [21, 56]. Furthermore, it seems important to incorporate the influence of (social) environmental factors in the COSFI, such as the presence of an informal caregiver who facilitates an older person in performing activities of (instrumental) daily living. Although people with severe cognitive impairments are more likely to lose self-sufficiency, the questionnaires of the COSFI were not feasible for them [57]. In clinical practice however, this is a relevant group of older adults. For future studies and use in clinical practice, it is recommended to assess which adjustments to the Core Outcome Set or measurement procedure can be made to include this vulnerable group.

Conclusion

In this study discriminative validity of the COSFI was assessed in a population of Dutch, older adults (≥ 65 years of age) with different levels of FI. The current composition of the COSFI, did not yet meet the COSMIN criteria for discriminative validity. However, with some adjustments, the COSFI has the potential to become a valuable instrument for clinical practice. This study indicates that the COSFI is moderately able to discriminate older people with different levels of Functional Independence. For 68% of older adults, the prediction of group membership by the COSFI is accurate. The COSFI has limited ability to distinguish between older adults living at home and dependent on help in (i)ADL and other groups. It is recommended to preserve the domains 'physical capacity', 'coping' and 'health literacy' as core elements of the COSFI. Complementary, in further research a measurement of environmental factors should be incorporated in the COSFI to improve clinical relevance in daily practice.

REFERENCES

- Candela F, Zucchetti G, Magistro D. Individual correlates of autonomy in activities of daily living of institutionalized elderly individuals: an exploratory study in a holistic perspective. *Holist Nurs Pract*. 2013;27(5):284–91.
- Groessl EJ, Kaplan RM, Rejeski WJ, Katula JA, King AC, Frierson G, et al. Health-related quality of life in older adults at risk for disability. *Am J Prev Med*. 2007;33(3):214–8.
- van Campen C, Iedema J, Broese van Groenou M, Deeg D. Langer zelfstandig; ouder worden met hulpbronnen, ondersteuning en zorg. Centraal Cultureel Planbureau; 2017.
- Buist Y, de Bruin S, Rijken M, Lemmens L, van Vooren N, Baan C. Vroegsignalering bij (kwetsbare) ouderen: wat is nodig om samenwerking te verbeteren: Rijksinstituut voor Volksgezondheid en Milieu (RIVM); 2018.
- deCarvalho IA, Epping-Jordan J, Beard JR. Integrated Care for Older People; Guidelines on community-level interventions to manage declines in intrinsic capacity: World Health Organization; 2018.
- Baltes MM. Dependency in Old Age ; Gains and Losses. *Curr Dir Psychol Sci*. 1995;4(1):14–9.
- Faul AC, Yankeelov PA, Rowan NL, Gillette P, Nicholas LD, Borders KW, et al. Impact of geriatric assessment and self-management support on community-dwelling older adults with chronic illnesses. *J Gerontol Soc Work*. 2009 Apr;52(3):230–49.
- Lee W-J, Chen L-K, Peng L-N, Chiou S-T, Chou P. Personal mastery attenuates the adverse effect of frailty on declines in physical function of older people: a 6-year population-based cohort study. *Medicine (Baltimore)*. 2016 Aug;95(34):e4661.
- Jenkins LS, Gortner SR. Correlates of self-efficacy expectation and prediction of walking behavior in cardiac surgery elders. *Ann Behav Med*. 1998;20(2):99–103.
- Cardol M, de Jong BA, van den Bos GAM, Beelem A, de Groot IJM, de Haan RJ. Beyond disability: perceived participation in people with a chronic disabling condition. *Clin Rehabil*. 2002 Feb;16(1):27–35.
- Steyerberg EW, Vickers AJ, Cook NR, Gerds T, Gonen M, Obuchowski N, et al. Assessing the performance of prediction models: a framework for traditional and novel measures. *Epidemiology*. 2010 Jan;21(1):128–38.
- Prinsen CAC, Vohra S, Rose MR, Boers M, Tugwell P, Clarke M, et al. How to select outcome measurement instruments for outcomes included in a ‘Core Outcome Set’ - a practical guideline. *Trials*. 2016;17:1.
- Lamb SE, Keene DJ. Measuring physical capacity and performance in older people. *Best Pract Res Clin Rheumatol*. 2017 Apr;31(2):243–54.
- Mijnarends Msc DM, Meijers JMM, Halfens JG, Luiking YC, Schoberer Msc D, Jentoft AJC, et al. Validity and reliability of tools to measure muscle mass, strength, and physical performance in community-dwelling older people: a systematic review. *J Am Med Dir Assoc*. 2013;14:170–8.
- Freiberger E, De Vreede P, Schoene D, Rydwick E, Mueller V, Frändin K, et al. Performance-based physical function in older community-dwelling persons: a systematic review of instruments. *Age Ageing*. 2012;41(6):712–21.
- Rossiter-Fornoff JE, Wolf SL, Wolfson LI, Buchner DM. A cross-sectional validation study of the FICSIT common Data Base static balance measures. *J Gerontol Ser A*. 1995;50A(6):291–7.
- Kim J, Chon J, Kim H, Lee J, Yoo S, Kim D, et al. The association between fall history and physical performance tests in the community-dwelling elderly: a cross-sectional analysis. *Ann Rehabil Med*. 2017;41(2):239–47.
- Roberts HC, Denison HJ, Martin HJ, Patel HP, Syddall H, Cooper C, et al. A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardised approach. *Age Ageing*. 2011;40(4):423–9.
- Reijnierse EM, de Jong N, Trappenburg MC, Blauw GJ, Butler-Browne G, Gapeyeva H, et al. Assessment of maximal handgrip strength: how many attempts are needed? *J Cachexia Sarcopenia Muscle*. 2017;8(3):466–74.
- Vriezekolk JE, Van Lankveld WGMJM, Eijssbouts AMMM, van Helmond T, Geenen R, van den Ende CHMM. The coping flexibility questionnaire: development and initial validation in patients with chronic rheumatic diseases. *Rheumatol Int*. 2012;32(8):2383–91.
- Bravo P, Edwards A, Barr PJ, Scholl I, Elwyn G, McAllister M. Conceptualising patient empowerment: a mixed methods study. *BMC Health Serv Res*. 2015; 15(1):1–14.
- Cerezo PG, Juvé-Udina M-E, Delgado-Hito P. Concepts and measures of patient empowerment: a comprehensive review. *Rev da Esc Enferm da USP*. 2016;50(4):667–74.
- Rademakers J, Nijman J, Van Der Hoek L, Heijmans M, Rijken M. Measuring patient activation in the

- Netherlands: translation and validation of the American short form patient activation measure (PAM13). *BMC Public Health*. 2012;12(1):1.
24. Sørensen K, Van den Broucke S, Fullam J, Doyle G, Pelikan J, Slonska Z, et al. Health literacy and public health: a systematic review and integration of definitions and models. *BMC Public Health*. 2012;25:12–80.
 25. Fransen MP, Leenaars KEF, Rowlands G, Weiss BD, Maat HP, Essink-Bot ML. International application of health literacy measures: adaptation and validation of the newest vital sign in the Netherlands. *Patient Educ Couns*. 2014;97(3):403–9.
 26. Guralnik J, Ferrucci L, Simonsick E, Salive M, Wallace R. Lower-extremity function in persons over the age of 70 years as a predictor of subsequent disability. *N Engl J Med*. 1995;332:556–61.
 27. Guralnik JM, Ferrucci L, Pieper CF, Leveille SG, Markides KS, Ostir GV, et al. Lower extremity function and subsequent disability: consistency across studies, predictive models, and value of gait speed alone compared with the short physical performance battery. *J Gerontol A Biol Sci Med Sci*. 2000; 55(4):221–31.
 28. Dobson F, Hinman RS, Hall M, Terwee CB, Roos EM, Bennell KL. Measurement properties of performance-based measures to assess physical function in hip and knee osteoarthritis: a systematic review. *Osteoarthr Cartil*. 2012;20:1548–62.
 29. Bossers WJR, Van Der Woude LHV, Boersma F, Scherder EJA, Van Heuvelen MJG, Bossers W. Recommended measures for the assessment of cognitive and physical performance in older patients with dementia: a systematic review. *EXTRA. Dement Geriatr Cogn Dis Extra*. 2012;2(1):589–609.
 30. Hafsteinsdóttir TB, Rensink M, Schuurmans M. Clinimetric properties of the timed up and go test for patients with stroke: a systematic review. *Top Stroke Rehabil*. 2014 May 22;21(3):197–210.
 31. Podsiadlo D, Richardson S. The timed 'up & go': a test of basic functional mobility for frail elderly persons. *J Am Geriatr Soc*. 1991;39:142–8.
 32. Peolsson A, Hedlund R, Birgitta O. Intra- and inter-tester reliability and reference values for hand strength. *J Rehabil Med*. 2001;33(1):36–41.
 33. Bohannon RW, Schaubert KL. Test-retest reliability of grip-strength measures obtained over a 12-week interval from community-dwelling elders. *J Hand Ther*. 2005;18(4):426–8.
 34. Kim JK, Park MG, Shin SJ. What is the minimum clinically important difference in grip strength? *Clin Orthop Relat Res*. 2013;472(8):2536–41.
 35. Hibbard JH, Mahoney ER, Stockard J, Tusler M. Development and testing of a short form of the patient activation measure. *Health Serv Res*. 2005;40(6):1918–30.
 36. Skolasky RL, Green AF, Scharfstein D, Boulton C, Reider L, Wegener ST. Psychometric properties of the patient activation measure among multimorbid older adults. *Health Serv Res*. 2011;46(2):457–78.
 37. Mokkink LB, Prinsen CAC, Patrick DL, Alonso J, Bouter LM, de Vet HCW, et al. COSMIN Study Design Checklist for Patient-reported outcome measurement instruments. Department of Epidemiology and Biostatistics; Amsterdam Public Health research institute; Amsterdam University Medical Centers, location VUmc;.
 38. Mokkink LB, Prinsen CAC, Patrick DL, Alonso J, Bouter LM, De Vet HCW, et al. COSMIN methodology for systematic reviews of Patient-Reported Outcome Measures (PROMs). User Manual; 2018;(February). p. 1–78.
 39. Terwee CB, Bot SDM, De Boer MR, Van Der Windt AWM, Knol DL, Dekker J. Quality criteria were proposed for measurement properties of health status questionnaires. *J Clin Epidemiol*. 2007;60:34–42.
 40. Kempen GIJM, Miedema I, Ormel J, Molenaar W. The assessment of disability with the Groningen activity restriction scale. Conceptual framework and psychometric properties. *Soc Sci Med*. 1996;43(11):1601–10.
 41. Gaugler JE, Duval S, Anderson KA, Kane RL. Predicting nursing home admission in the U.S: a meta-analysis. *BMC Geriatr*. 2007;7(13):1471–2318.
 42. Tinetti ME, Williams CS. Falls, injuries Due to falls, and the risk of admission to a nursing home. *N Engl J Med*. 1997 Oct 30;337(18):1279–84.
 43. Vejux J, Ben-Sadoun G, Piolet D, Bernat V, Ould-Aoudia V, Berrut G. Screening risk and protective factors of nursing home admission. *Geriatr Psychol Neuropsychiatr Vieil*. 2019;17(1):39–50.
 44. Berkman N, Sheridan S, Donahue K, Halpern D, Crotty K. Low Health Literacy and Health Outcomes: An Updated Systematic Review. *Ann Intern Med*. 2011;155:2.
 45. Vittinghoff E, McCulloch CE. Relaxing the rule of ten events per variable in logistic and cox regression. *Am J Epidemiol*. 2007;165(6):710–8.
 46. de Klerk M, Verbeek-Oudijk D, Plaisier I, den Draak M. Zorgen voor thuiswonende ouderen, Kennissynthese

- over de zorg voor zelfstandig wonende 75-plussers, knelpunten en toekomstige ontwikkelingen. Den Haag; 2019.
47. Fried LP, Guralnik JM. Disability in older adults: evidence regarding significance, etiology, and risk. *J Am Geriatr Soc.* 1997 Jan 1;45(1):92–100.
 48. Geboers B, Reijneveld SA, Jansen CJM, de Winter AF. Health literacy is associated with health behaviors and social factors among older adults: results from the LifeLines cohort study. *J Health Commun* 2016;21(0):45–53.
 49. Von Wagner C, Knight K, Steptoe A, Wardle J. Functional health literacy and health-promoting behaviour in a national sample of British adults. *J Epidemiol Community Health.* 2007;61(12):1086–90.
 50. Greene J, Hibbard JH, Sacks R, Overton V, Parrotta CD. When patient activation levels change, health outcomes and costs change. *Too Health Aff.* 2015;34(3):431–7.
 51. Keysor JJ, Jette AM, Coster W, Bettger JP, Haley SM. Association of Environmental Factors with Levels of home and community participation in an adult rehabilitation cohort. *Arch Phys Med Rehabil.* 2006;87(12):1566–75.
 52. Avlund K, Lund R, Holstein BE, Due P. Social relations as determinant of onset of disability in aging. *Arch Gerontol Geriatr.* 2004;38(1):85–99.
 53. Linden M, Horgas A, Gilberg R, Steinhagen-Tiesen E. Predicting health care utilization in the very old. *J ageing Heal.* 1997;9(1):3–27.
 54. de Vet HCW, Terwee CB, Mokkink LB, Knol DL, de Vet HCW, Terwee CB, et al. Concepts, theories and models, and types of measurements. In: *Measurement in medicine.* Amsterdam: Cambridge University Press; 2011. p. 7–29.
 55. 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):136–47.
 56. Werbrouck A, Swinnen E, Kerckhofs E, Buyl R, Beckwée D, De Wit L. How to empower patients? A systematic review and meta-analysis. *TBM.* 2018;8(5):660–74.
 57. Overdorp EJ, Kessels RPC, Claassen JA, Oosterman JM. The combined effect of neuropsychological and Neuropathological deficits on instrumental activities of daily living in older adults: a systematic review. *Neuropsychol Rev.* 2016;26(1):92–106.

ADDITIONAL FILE 1.

Forward, stepwise ordinal regression. Contribution of each of the domains physical capacity, coping, empowerment and health literacy to the model based on the COSFI, determined by forward, stepwise ordinal regression.

Model	1	2	3	4	5	6	7	8	9
Intercept only	x								
Physical ca- pacity		x	x	x	x	x	x	x	x
Coping			x			x		x	x
Empowerment				x		x	x		x
Health literacy					x		x	x	x
intercept only	10,687	359,872	382,524	379,752	372,009	382,524	382,524	383,911	383,911
log-likelihood	10,687	233,627	254,545	253,437	242,247	254,122	252,728	253,115	252,868
df	0	2	4	3	3	5	4	5	6

Comparison	model 2-3	model 2-4	model 2-5	model 2-6	model 2-7	model 2-8	model 2-9	model 3-6	model 3-8	model 3-9
log-likelihood 1	-233,627	-233,627	-233,627	-233,627	-233,627	-233,627	-233,627	-254,545	-254,545	-254,545
log-likelihood 2	254,545	253,437	242,247	254,122	252,728	253,115	252,868	254,122	253,115	252,868
LR	20,918	19,810	8,620	20,495	19,101	19,488	19,241	-0,423	-1,430	-1,677
	41,836	39,620	17,240	40,990	38,202	38,976	38,482	-0,846	-2,860	-3,354
df	2	1	1	3	2	3	4	3	3	4
p	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	>0.25	>0.25	>0.25

Chapter 4

Cluster Analysis of Functional Independence in Community-Dwelling Older People

Esther Molenaar, Di-Janne Barten, Anne de Hoop,
Nienke Bleijenberg, Niek de Wit, Cindy Veenhof

BMC Geriatrics. 2022; 22; 996

DOI: 10.1186/s12877-022-03684-2

ABSTRACT

Background: The concept of Functional Independence (FI), defined as ‘functioning physically safe and independent from other persons, within one’s context’, plays an important role in maintaining the functional ability to enable well-being in older age. FI is a dynamic and complex concept covering four clinical outcomes: physical capacity, empowerment, coping flexibility, and health literacy. As the level of FI differs widely between older adults, healthcare professionals must gain insight into how to best support older people in maintaining their level of FI in a personalized manner. Insight into subgroups of FI could be a first step in providing personalized support. This study aims to identify clinically relevant, distinct subgroups of FI in Dutch community-dwelling older people and subsequently describe them according to individual characteristics.

Results: One hundred fifty-three community-dwelling older persons were included for participation. Cluster analysis identified four distinctive clusters: (1) Performers – Well-informed; this subgroup is physically strong, well-informed and educated, independent, non-falling, with limited reflective coping style. (2) Performers – Achievers: physically strong people with a limited coping style and health literacy level. (3) The reliant- Good Coper representing physically somewhat limited people with sufficient coping styles who receive professional help. (4) The reliant – Receivers: physically limited people with insufficient coping styles who receive professional help. These subgroups showed significant differences in demographic characteristics and clinical FI outcomes.

Conclusions: Community-dwelling older persons can be allocated to four distinct and clinically relevant subgroups based on their level of FI. This subgrouping provides insight into the complex holistic concept of FI by pointing out for each subgroup which FI domain is affected. This way, it helps to better target interventions to prevent the decline of FI in the community-dwelling older population.

Keywords: Functional independence · Older persons · Subgrouping

BACKGROUND

The global aging of the population causes an increase in the prevalence of associated diseases (1). This increased burden of most chronic diseases results in a vicious circle of limitations in physical performance followed by constraints in (instrumental) daily life activities (2). To prevent these medical and social consequences and to respond to the accompanying increased pressure on healthcare professionals and the healthcare system, a conceptual change in care for older people is urgently needed. In line with the approach to healthy aging, it is advocated that future care for older people should aim to maintain the functional ability to enable well-being in older age (3, 4). It is advocated that preserving functional ability, with proactive instead of reactive care for older people, will lead to the prevention of limitations in daily life activities and maintaining 'Functional Independence' for as long as possible (5). Functional Independence (FI) is defined as 'Functioning physically safe and independent from other persons, within one's context (6)'. The conceptual model of FI, aligned with the International Classification of Functioning, disability, and health (ICF), consists, as interpreted by Molenaar et al., of both physical and personal features such as coping, empowerment, and health literacy. In addition safety and contextual factors of the individual contribute to FI. Figure 1 shows the complexity of the individual FI state influenced by the different constructs (6). This aligns with the definition of health being a dynamic state, in which the emphasis is on the ability to adapt and self-manage, expressed in Fig. 1 by the considerable part of the personal factors (coping, empowerment, and health literacy) (7).

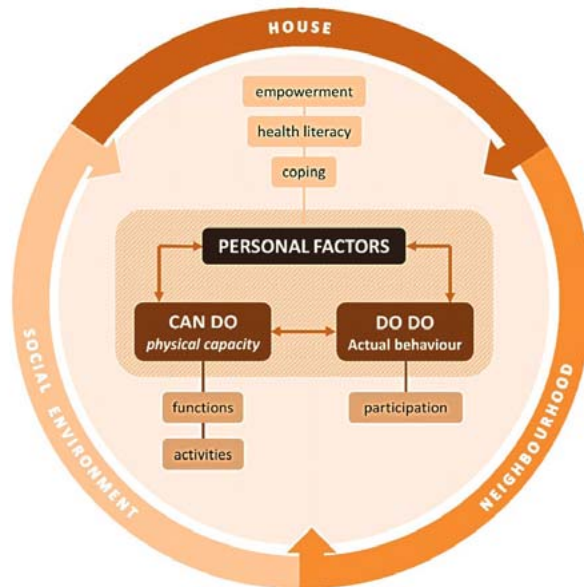


Fig. 1 Graphical display of the concept of Functional Independence in community-dwelling older persons. It shows the complexity of compromising the concept of Functional Independence which consists of different constructs.

Proactive care in older people and healthy aging include early recognition of older persons at risk of losing their FI (8). This can be facilitated by monitoring FI among community-dwelling older people and timely referral to an appropriate care professional (9). However, FI is a dynamic and complex concept in which large individual differences exist. Therefore, it is likely that dividing this population into subgroups will give insight into the domain or domains affected in each group. This may lead to enabling tailored engagement of particular healthcare professionals. In this way, identifying clinical subgroups may lead to better treatment and prevention of decline in FI (9, 10). Therefore, to help healthcare professionals to timely recognize persons at risk of losing FI, and to develop healthcare policy, the identification of subgroups is necessary (10). In this study, we aimed to identify distinct subgroups of FI in Dutch community-dwelling older adults and describe them according to individual characteristics.

METHODS

Design and setting

This study has an observational, cross-sectional design (6). A retrospective analysis of previously collected data for validation of a Core Outcome Set measuring FI (COSFI), in community-dwelling older people in the city of Utrecht, The Netherlands, was carried out (11). Measurements took place in two different districts of Utrecht. Public locations, in the community, that were easily accessible for older persons, such as community centers, fitness centers, and physical therapy practices, were used as test locations; persons who were unable to visit the test location were offered a home assessment.

Participants

Older people were eligible for participation if they met the following inclusion criteria: (a) ≥ 65 years of age and (b) living in the community. As this study focuses specifically on retaining FI and preventing FI decline, we excluded people living in care homes that received institutional care (c). In addition, persons were excluded when they: (d) were unable to understand verbal and written instructions in Dutch or (e) had an insufficient cognitive level to independently complete the required questionnaires. Eligibility of cognitive level was established by the clinical view of the research team; older adults who experienced such severe cognitive problems that hindered the appropriate completion of the questionnaires were excluded. Participants were recruited in different ways. District nurses, physical therapists, social workers, and neighbourhood sports coaches from the two districts were asked to promote the study among older clients. Additionally, public promotional activities were used to recruit participants for the study (e.g. spreading flyers at supermarkets and community centers, hanging posters in public places, and advertising on local and social media).

Study outcome

The primary outcome of this study is the validated subgrouping of FI in community-dwelling older people based on COSFI scores. As mentioned previously, FI represents a complex, personalized

construct that comprises different domains, including a person's physical capacity, coping style, health literacy, independence, and fall history (6). Discriminative validity of the COSFI is moderate for predicting the different levels of FI but good for differentiating FI according to the living situation (i.e., older people in residential care and community-dwelling older people) (11). The secondary outcome is a description in detail of the derived subgroups of FI, combining the COSFI outcomes and demographic characteristics. The COSFI covers specific domains of FI, also presented in Table 1:

Table 1 Content of the specific domains of Functional Independence covered by the Core Outcome Set Functional Independence

Domain of FI	Measurement	Target population
Physical capacity	SPPB	Older adults
	FICSIT-4	Older adults
	JAMAR	General population and community-dwelling older adults
Coping	COFLEX: The COFLEX versatility scale and COFLEX reflective scale	Patients with chronic reumatoid arthritis
Health literacy	NVS-D	Older adults
Independence	Received professional help; Yes or No	n/a
Fall history	1 or more falls in the past; Yes or No	n/a

SPPB = Short Physical Performance Battery; FICSIT = Frailty and Injuries Cooperative Studies of Intervention Techniques; JAMAR; JAMAR Hand Held Dynamometer; TUG = Timed Up and Go test; COFLEX = Coping Flexibility questionnaire; NVS-D = Dutch Newest Vital Sign; AUC = Area Under the Curve; ICC = Intraclass Correlation Coefficient; MCID = Minimal Clinically Important Difference

Measurements

Physical capacity

Physical capacity was operationalized as 'the ability to perform daily life activities' (12). It was measured by four different measurement instruments, that are complementary in covering the essential components of physical capacity related to the ability to safely perform daily life activities. Furthermore, these instruments are validated in the targeted population of older adults and are feasible in daily practice: The Short Physical Performance Battery (SPPB); this instrument is highly recommended to assess physical capacity in terms of validity, reliability, and responsiveness in community-dwelling older persons (13, 14). It contains three subscales: balance, gait speed, and lower extremity strength (15). As a supplement to the SPPB, the Frailty and Injuries Cooperative Studies of Intervention Techniques (FICSIT-4) measurement instrument was added to test static balance more extensively (16). Additionally, hand-grip strength was assessed by using the hand-grip strength procedure of the JAMAR Hand-Held Dynamometer (JAMAR) (17). Hand-grip strength is a reliable and valid characteristic to get insight into overall muscle strength in older people (18, 19). Furthermore, the Timed Up and Go test (TUG) is a valid tool for screening balance deficits in senior citizens (20). It is an important part of the physical capacity domain of FI since the dynamic balance during walking also plays an important part in functioning independently (21). The amount of time needed to stand up from a chair, walk 3 meters, walk back to a chair, and sit down again is scored; a

maximum score of 240 seconds is registered when participants are not capable to execute the TUG test.

Coping

Coping concerning FI was interpreted as dynamic cognitive and behavioral efforts to manage a decline in physical function or physical disability (22). The COping FLEX-ibility questionnaire (COFLEX) was used to assess coping in the current study. The COFLEX is a tool to measure one's ability to use both assimilative and accommodative coping strategies to deal with stressors in different situations (23). The COFLEX is divided into two subscales that were analyzed separately: coping versatility (9 items) and reflective coping (4 items). Coping versatility refers to the ability to switch between using existing knowledge and skills or adapting existing skills and knowledge to deal with a new situation, following personal goals and situational demands (23). For instance, adjustment of physical goals when a chronic disease causes constraints in physical functioning and the existing goal isn't obtainable anymore (24). Reflective coping represents someone's ability to generate different coping options and to make a considered choice of the most suitable coping strategy in a given situation. For example, when the balance of an older person is affected, this person should take this into account in his or her choice of coping strategy, in which he or she has to make a considered decision concerning safety in a certain situation.

Health literacy

Health literacy is an interaction between the skills of the individual to obtain, process, and understand health information and services necessary to make appropriate health decisions and a requirement of the health system (25). Health literacy was assessed with the Dutch version of the Newest Vital Sign (NVS-D) (23). The NVS-D is a valid and reliable screening tool that identifies patients at risk for low health literacy (26). It contains six questions to assess one's level of health literacy by determining an individual's ability to find and interpret information on an ice cream nutrition label.

Independence

To monitor the level of independence, a variable concerning receiving help from other persons was added. Because this help can also be convenient and not necessary, we specifically asked if professional help, by which we mean paid help in a person's home, was received by asking the following question: "Do you receive professional help?". This question could be answered by 'yes' or 'no'.

Fall history

Safety is an important feature of FI (8). Functioning safely in the context of daily life includes a minimal risk of falling. As falling in the past year is an important predictor of the risk of falling in the future, we added a question concerning falling in the past, which is widely used in fall screening of older people: "Have you fallen in the past year?" This question could be answered by 'yes' or 'no' (27).

Additional characteristics

Demographic data of the participating older people were collected on age (years), gender (male, female, unknown), and educational level according to the Dutch Central Bureau of Statistics; High (associate degree programs, higher education bachelor programs; Master degree programs, Middle (upper secondary education, (basic) vocational training and middle management and specialist education) and Low (primary and special primary education), multimorbidity (i.e., the presence of more than one chronic disease in an individual) (0–2, > 2 chronic diseases) (28), and living situation. The living situation was subdivided into community-dwelling; living alone, community-dwelling; with someone else, and living in a supported house. This last subgroup refers to a group of older persons whose accommodation is provided alongside support, supervision, or care to help them live as independently as possible in the community (community-dwelling alone, community-dwelling with a partner, living in a supported house).

Statistical analyses

Agglomerative hierarchical binary cluster analysis, applying Ward's method and between-group linkage with squared Euclidean Distance measure, was used to identify clusters of FI in community-dwelling older people (30).

Data transforming

In preparation for the cluster analysis, the ordinal and continuous outcome scales of the COSFI (JAMAR, SPPB, NSVD, and the COFLEX versatility scale and COFLEX reflective scale) used in the cluster analysis were first converted to binary variables to meet the assumption for similar outcome scales (29). For a transition from ratio and ordinal variables to binary variables, we used the clinical cut-off point; (0 = beneath the cut-off point) (1 = above the cut-off point) (15, 18, 30). For a transition of the JAMAR outcomes, a subdivision between men and women was made as proposed by Arvandit et al. (31). When a clinical cut-off point was not available, we used the mean score as a proxy variable; (0 = beneath the mean score 1 = above the mean score).

Handling missing data

Participants were excluded in case of missing values on one of the clustering variables since the analysis did not allow missing values. Imputation was not performed because the missingness was not severe (< 5%) and the data was Missing Completely at Random (MCAR) (32).

Assumptions for cluster analysis

Subsequently, assumptions for agglomerative hierarchical binary cluster analysis were investigated. The clustering variables from the COSFI were checked on multicollinearity. If the correlation coefficient (Pearson r) was ≥ 0.90 , the variable was excluded from the cluster analysis (33). Furthermore, the assumption for similar outcome scales was met as we converted the different outcome scales to binary variables.

Model fitting

To identify distinct clusters, first, a visual assessment of the dendrogram and the agglomeration schedule was performed by two researchers (EM, JB). The visual representations of the cluster analysis, the hierarchical dendrogram, and the agglomeration schedule were inspected individually. The results from the dendrogram and the agglomerative schedule showed the change in the agglomerative coefficient, indicating possible cluster solutions in which clusters indicated the best similarities and deviations on domains of FI. The graphical display shows the distance within the clustering algorithm until joining the next cluster. Possible plausible numbers of cluster solutions were selected by the two first authors.

Validation of the cluster solution

To determine to what extent the derived clusters are distinguishing, we examined scores on domains of FI per derived cluster. This analysis comprised a between-cluster comparison of COSFI scores on each domain to examine if the number of clusters chosen by the researchers has resulted in clinically distinctive groups concerning the results of the measurements included in the COSFI. Chi-square tests were used to examine differences in scores on domains of FI between the different clusters.

Sensitivity analyses

This analysis comprised a between-cluster comparison of participant demographics to examine differences in population characteristics between subgroups of FI. One-way ANOVA was used to compare the mean age and BMI between different subgroups of FI. If data were not normally distributed, an alternate parametric test was obliged. The categorical outcomes (educational level and living situation) were compared by using the Kruskal-Wallis test and Chi-square tests were used for nominal data (gender and co-morbidity).

An overview of participant demographics and outcomes of the cluster analysis was created to display the different subgroups in FI.

All statistical analyses were performed in IBM SPSS Statistics (version 25, IBM Corp., Armonk, N.Y., USA).

Sample size

Because this study was a retrospective analysis of existing data within an overarching research project, we used a convenience sample of all participants available meeting the inclusion criteria ($N = 153$). Clear guidelines regarding the minimum sample size in cluster analysis are lacking (32). The goal of this cluster analysis is to construct clinically relevant clusters, so the number of variables should be proportional to the sample size. We used a commonly accepted rule of thumb to estimate the desired number of participants (34). The use of eight different cluster variables led to an estimated number of $2^8 = 256$ Participants. When a variable is excluded due to a correlation coefficient of ≥ 0.90 an estimated number of 27 leads to an estimated number of 128 (35).

Ethics

Ethical approval for the study was obtained by the Research Ethics Committee of Utrecht University of Applied Sciences (reference number 85_000_2019). No personally identifying data were incorporated into the dataset. Informed consent forms were signed by participants before study participation. The whole test procedure took 60 min, participants were guided through the test procedure and were offered help filling in the questionnaires. Participants were allowed to rest or take a break whenever they wanted.

RESULTS

Participant demographics

A total of 153 community-dwelling older persons were included for participation in the study. Participants' age ranged from 65 to 95 years (79 ± 7.5 years), with 67% identified as female. Demographic characteristics and outcomes of COSFI measures are shown in Table 2.

Table 2 Characteristics of participants

Characteristics	(n = 153)
Age (yr.), mean (SD)	79 (7.5)
Gender (%)	
Male	41
Female	59
Unknown	0
Receiving professional help, yes (%)	54
Educational level (%)	
High	17
Middle	35
Low	48
Number of Falls, mean (SD)	1.5 (0.7)
BMI (kg/m ²); mean (SD)	28.9 (7.1)
Co-morbidities (% >2)	73
Living situation (%)	
Community-dwelling alone	63
Community-dwelling with a partner	37
JAMAR, mean (SD)	29.6 (11.7)
Male	38.9 (11.3)
Female	23.3 (6.7)
NVSD, median (IQR)	3 (3)
TUG, median (IQR)	9.9 (8.9)
COFLEX V, median (IQR)	27 (9)
COFLEX R, median (IQR)	11.5 (4)
SPPB, median (IQR)	9 (4)
FICSIT-4, mean (SD)	18.4 (7.3)

SD= Standard Deviation; IQR= InterQuartile Range; JAMAR= JAMAR hand held dynamometer; NVS-D = Dutch Newest Vital Sign; TUG = Timed Up and Go test; SPPB = Short Physical Performance Battery; COFLEX = Coping Flexibility questionnaire; COFLEX versatility scale and COFLEX reflective scale; FICSIT = The Frailty and Injuries Cooperative Studies of Intervention Techniques

Identified subgroups of FI in community-dwelling older people

The pre-analysis check for multicollinearity showed a high correlation between the outcomes of the FICSIT-4 instrument and the SPPB ($r \geq 0.90$). We chose to include the SPPB since the SPPB is more extensive and covers multiple domains in contrast to the FICSIT-4 which only covers the balance domain. Therefore, we excluded the FICSIT 4 outcome from the hierarchical cluster analysis.

The visual inspection of the dendrogram of the hierarchical cluster analysis showed from top-down two large clusters. The research team considered two clusters not to be clinically feasible since the dichotomy would not be specific enough to guide clinical follow-up. Therefore consensus was reached on a 4-cluster solution derived from the first two clusters being the most appropriate cluster solution (35) (Fig. 2); a horizontal line through the dendrogram on the number of options shows the most clinically plausible solution considering diversity between persons in aspects of FI.

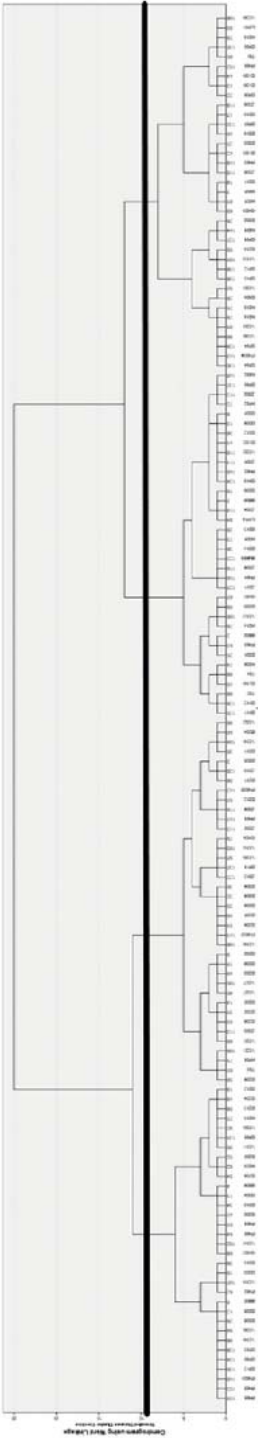


Fig. 2 Dendrogram hierarchical cluster analysis of the Core Outcome Set of Functional Independence in community-dwelling older persons. A horizontal line pierces the four clusters of the most appropriate cluster solution

Clusters are rated from highest to lowest FI level and labelled according to characteristics (Fig. 3 and Table 3).

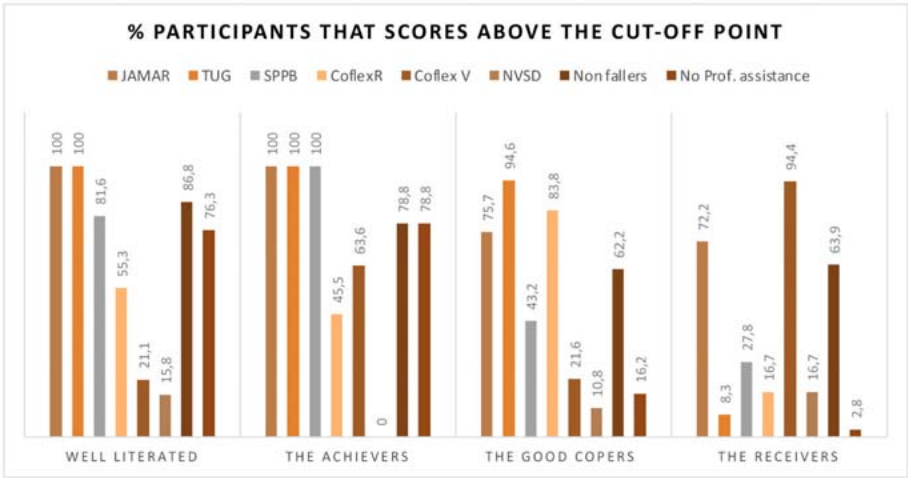


Fig. 3 Graphical display of achieved scores on cluster variable per subgroup. It shows the percentage of participants in the cluster that scores above the cut-off point on the cluster variables from the Core Outcome Set of Functional Independence

Table 3 Description and names of the different subgroups as a result of the hierarchical cluster analysis on variables concerning Functional Independence

Cluster	Characteristics	Name
Cluster 1	Physically strong, Well Informed and educated, independent, non-faller, limited reflective coping style	The Performers - Well Informed
Cluster 2	Physically strong however a limited versatility coping style and health literacy level.	The Performers - Achievers
Cluster 3	Physically somewhat limited, sufficient coping styles, however, do receive professional help	The reliant- Good Copers
Cluster 4	Physically limited, insufficient coping styles, receives professional help. Least level of functional independence in total.	The reliant - Receivers

Subgroups 1 and 2: the Performers

Persons in cluster 1 score overall the best on all aspects of FI, they show scores above the mean or cut-off point on all measurements except for the COFLEX versatility scale. The average older person in cluster 1 does not fall or receive professional help in addition, there are only male older persons in this subgroup. Both clusters 1 and 2 score well on the physical outcome measures, and therefore are mentioned as The Performers, however, this group has an average sufficient health literacy level and therefore is named the Well informed.

The average scores on the physical measurements in cluster 2 are above the cut-off points. Furthermore, most persons in cluster 2 like in subgroup 1 do not fall nor receive help. Also, there are more male older people than females in this group. However, they score below the mean score of the COFLEX reflective scale and the cut-off point of the NVSD measurement tool for health literacy. Because of the overall adequate achievements on the physical performance measurement tools, this group is called the Achievers.

Subgroups 3 and 4: the Reliant

In cluster 3, the SPPB is scored mostly below the cut-off point. Furthermore, more than 97% of the persons in this cluster receive professional help, and therefore, this group is mentioned together with subgroup 4 as The Reliant. On the other hand, the average person in cluster 3 scores above the mean score on the COFLEX reflective scale. Hence, the name of the subgroup is The Good Copers.

Cluster 4 is characterized by the large number of persons receiving professional help. Furthermore, scores are mostly below the average and cut-off points, which makes it the cluster with the lowest level of FI of the four clusters. As they are most likely to receive professional help at the moment and in the future, this subgroup is named The Receivers.

Validation of the cluster solution

To determine to what extent the derived clusters are distinct, we examined significant differences in COSFI outcomes between subgroups of FI. This analysis showed a significant difference between the established clusters in COSFI measurement scores. Table 4 shows significant ($p \leq 0.05$) differences for 7 out of 8 measurement outcomes of the COSFI. Only the Timed Up and Go test did not differ significantly between the four groups.

Table 4 Differences between groups in measurement outcomes of the Core Outcome Set Functional Independence

Domain of FI	Measurement	Cut-off points	Well informed	The achievers	The good copers	The receivers
			N=38	N=33	N=37	N=36
Physical capacity	JAMAR*	Above	38	33	28	26
		Below	0	0	9	10
	SPPB*	Above	31	33	16	10
		Below	7	0	21	26
	TUG	Above	38	33	35	33
		Below	0	0	2	3
Coping	COFLEX V *	Above	17	18	31	6
		Below	21	15	6	30
	COFLEX R*	Above	8	21	8	34
		Below	30	12	29	2
Health literacy	NVSD*	Above	32	0	4	6
		Below	6	33	33	30
Independence	Receiving professional help*	No	29	33	6	1
		Yes	9	0	31	35
Fall history	Falling*	No	33	26	23	23
		Yes	5	7	14	13

NVS-D = Dutch Newest Vital Sign; TUG = Timed Up and Go test; COFLEX = Coping Flexibility questionnaire; V= versatility scale and R= reflective scale; SPPB = Short Physical Performance Battery; * = significant difference between groups $p < 0.05$

Table 5 Differences in participant demographics between the four clusters of Functional Independence

Demographics	Well Informed n=38	The achievers n=33	The good copers n=37	The receivers n=36
Age (yr), mean (SD)	75.6 (6.7)*	76.7 (6.6)*	81.8 (6.3)*	82.8 (7.3)*
Gender (% Male)	100	74	54	50
BMI (kg/m ²), mean (SD)	29.1(6.3)	29.8(7.0)	26.7(6.2)	30.5(8.4)
Educational level (%)				
High	42**	11**	8	8**
Middle	32**	24**	49	36**
Low	26**	64**	43	56**
Co-morbidities, yes (%)	55*	67*	76*	89*
Living situation (%)				
Community-dwelling alone	50	55	65	50
Community-dwelling with a partner	48	45	30	31
Community-dwelling living in a supported house	2	0	5	19

* = significant difference between groups $p \leq 0.05$; ** = educational level differs significantly ($p = 0.05$) between clusters 1 and 2, and 1 and 4

Sensitivity analyses

Significant differences ($p \leq 0.05$), in participant demographics, between all groups, were found in age and co-morbidities. In addition, a significant difference ($p \leq 0.05$) was found in the education level between clusters 1 and 2, and 1 and 4 (Table 5).

DISCUSSION

The primary aim of the study was to identify clinically relevant subgroups of functional independence in community-dwelling older adults. As FI consists of different domains in which different professionals are required, the division into subgroups could provide insight into who might need help in which domain. Hierarchical cluster analysis identified four distinctive subgroups of FI in community-dwelling older adults. These sub-groups showed significant differences in clinical COSFI outcomes and were distinct from each other regarding demographic characteristics like age, gender, educational level, and presence of co-morbidity, which makes the subdivision also clinically relevant.

Comparison with literature

The results of our study and the established subgroups are in line with recent literature determining the relation between age, falling, co-morbidities, and increased demand for help (36, 37). In addition, other studies show similarities between the reliant groups and frail older people. In particular, the group that is most dependent on assistance shows similarities in terms of physical outcomes as well as coping and health literacy outcomes in comparison with frail older people (38). It underlines the important role of physical status in the concept of FI (11). In addition, the absence of female persons in the Well-informed group is remarkable. However, as female older persons show a larger decrease in functional status decline, it is likely that this group, which scores the best on the functional performance tests, is dominated by males (39). Moreover, earlier studies demonstrated the relationship between educational level and health literacy level, as older female persons are overall less educated this could also explain the diminished presence in addition low health literacy is associated with poorer health outcomes (40).

Clinical implications

Furthermore, this study shows the complex interaction between physical and cognitive or behavioral factors in maintaining FI. For instance, results show that persons scoring better on health literacy outcomes, but lower on the SPPB (the Well-informed group) are less likely to fall than persons in the Achievers' group who score better on all physical outcomes. Moreover, the Performers-achievers score so well on the physical performance tests that they may not need help with physical functioning. However, this group might benefit from help in coping when limitations are experienced. A different kind of health care professional will therefore have to be involved with persons in this group instead of persons as in the reliant-Good Coper group in which physical limitations are the most important issue. These differences between subgroups in performance on clinical outcomes underline the

importance of the holistic view of the FI concept and the relevance of establishing subgroups in FI based on the COSFI outcomes. Furthermore, it encourages inter-professional collaboration around this topic (6).

Strengths & limitations

Although a larger sample size is preferable, we made a well-considered choice of using hierarchical cluster analysis with Ward's method as this analysis is most suitable and frequently used in a small sample size (33, 34, 41). In addition, we converted variables to a similar binary scale to prevent one of the outcome measures from being a dominant factor in the analysis. To convert these variables, we utilized clinical cut-off values (42). By choosing a clinical cut-off point, we argue that the outcomes became clinically interpretable which makes it a study strength. However, the COFLEX did not have a clinical cut-off point, we chose the pragmatic solution by dividing persons scoring above and below the mean value on both the subscales of this measurement instrument to create a binary scale. It could be argued that this was the right solution. The mean value does indicate the result for the overall group. Though by using the mean value we created a fictive cut-off value that does not indicate persons scoring below the mean have inadequate coping behavior. These outcomes should be interpreted with caution, therefore.

Furthermore, the process of choosing the most appropriate number of clusters based on the dendrogram is a subjective matter. Authors could have had a preference for a practical, appropriate number of clusters to be feasible in healthcare practice. However, they analyzed the dendrogram individually and came to a similar choice. We found significant differences in all COSFI outcome measurements in the cluster analysis: JAMAR, SPPB, COFLEX V, COFLEX R, and the NVSD, between the different subgroups. This strengthens the choice for the four-cluster solution. The only exception was outcomes on the TUG. However, the choice of the cut-off point for these measurements could be debated. The participants in our study generally did not reach this cut-off point (only 5 out of 121 did) which may have caused bias in the interpretation of this outcome measure when treated as a binary measurement (43, 44). However it should be part of the COSFI considering the COSFI could also be used for measuring older persons with fewer FI levels, for instance, not community-dwelling.

Finally, as older persons with cognitive impairment were not able to complete the COSFI we chose to exclude these persons from participation in the study. However, we are aware of the influence of cognitive impairments on a person's level of independence and thus on the level of FI. As physical status and performance are centralized in FI, cognitive impairment is disregarded in this specific study.

Recommendations

FI is a complex concept, resulting from the interaction between physical, cognitive, and behavioral elements, with different outcome measures (6). To estimate prognosis and to personalize interventions, it is helpful and practical to allocate persons in subgroups according to differences in

outcome measures. In this way, the targets for interventions are better defined and consequently, it helps to decide which healthcare professional should be engaged (45). Further research investigates the practical relevance and recognizability of the four clusters and which cluster matches which caregiver (46).

The next step is to develop appropriate recommendations for the follow-up of each subgroup, in collaboration with multidisciplinary professionals and the target population. These recommendations could be used as guidance for decisions in the cure and care of individual persons to provide patient-centered care. In addition, these should be added to the needs of the individual and tailored by the attending care professional (47).

Furthermore, longitudinal studies are indicated to track the change of functional independence over time, validate the cluster results, and monitor the development of the different variables. This could give us insight into the most important indicator(s) for losing FI, which would allow us to intervene rapidly when the risk of losing FI occurs.

Conclusion

Community-dwelling older persons can be allocated to four distinct and clinically relevant subgroups based on their level of Functional Independence. This subgrouping provides insight into the complex holistic concept of Function Independence and helps to better target interventions to prevent the decline of functional independence in the community-dwelling older population.

Abbreviations

FI: Functional Independence; COSFI: Core Outcome Set Functional Independence; SPPB: The Short Physical Performance Battery; FICSIT-4: The Frailty and Injuries Cooperative Studies of Intervention Techniques; TUG: The Timed Up and Go Test; COFLEX: The Coping Flexibility questionnaire; NVS-D: The Dutch version of the Newest Vital Sign; MCAR: Missing Completely at Random; ICF: International Classification of Functioning, Disability and Health.

REFERENCES

- Christensen K, Doblhammer G, Rau R, Vaupel JW. Ageing populations: the challenges ahead. *The Lancet*. 2009;374(9696):1196–208.
- Clarke P, Smith J. Aging in a cultural context: cross-national differences in disability and the moderating role of personal control among older adults in the United States and England. *J Gerontol B Psychol Sci Soc Sci*. 2011;66(4):457–67.
- Rudnicka E, Napierala P, Podfigurna A, Meczekalski B, Smolarczyk R, Grymowicz M. The World Health Organization (WHO) approach to healthy ageing. *Maturitas*. 2020;139:6–11.
- de Wit NJ, Schuurmans MJ. Future care for older people in general practice: paradigm shifts are needed. *Br J Gen Pract*. 2017;67(664):500–501.
- Mortenson WB, Fuhrer MJ, Bilkey J, Jutai J, Alkadri J, Aziz J, et al. Comparing assessments of physical functional independence in older adults with mobility limitations. *Am J Phys Med Rehabil*. 2019;98(8):637–41.
- Molenaar EALM, Barten JA, te Velde S, van der Schoot L, Bleijenberg N, de Wit NJ, et al. Functional Independence in the Community Dwelling Older People: a Scoping Review. *Journal of Population Ageing*. 2020.
- Huber M, Knottnerus JA, Green L, van der Horst H, Jadad AR, Kromhout D, et al. How should we define health? *BMJ*. 2011;343:d4163.
- van Blijswijk SCE, Blom JW, de Craen AJM, den Elzen WPJ, Gussekloo J. Prediction of functional decline in community-dwelling older persons in general practice: a cohort study. *BMC Geriatr*. 2018;18(1):140–018.
- Speizer FE, Ware, James H - Ware JH. Exploring Different Phenotypes of COPD. *N Engl J Med*. 2015;373(2):185–186.
- Han MK, Agusti A, Calverley PM, Celli BR, Criner G, Curtis JL, et al. Chronic obstructive pulmonary disease phenotypes: the future of COPD. *Am J Respir Crit Care Med*. 2010;182(5):598–604.
- Dockx YJC, Molenaar, E A L M, Barten DJA, Veenhof C. Discriminative validity of the Core outcome set functional independence in a population of older adults. *BMC Geriatr*. 2020 August;26(1):309–020. 20(.
- Lamb SE, Keene DJ. Measuring physical capacity and performance in older people. *Best Pract Res Clin Rheumatol*. 2017;31(2):243–54.
- Freiberger E, de Vreede P, Schoene D, Rydwick E, Mueller V, Frandin K, et al. Performance-based physical function in older community-dwelling persons: a systematic review of instruments. *Age Ageing*. 2012 November 01;41(6):712–21.
- Guralnik JM, Ferrucci L, Simonsick EM, Salive ME, Wallace RB. Lower- extremity function in persons over the age of 70 years as a predictor of subsequent disability. *N Engl J Med*. 1995;332(9):556–61.
- Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, Blazer DG, et al. A short physical performance battery assessing lower extrem- ity function: association with self-reported disability and prediction of mortality and nursing home admission. *J Gerontol*. 1994;49(2):M85–94.
- Rossiter-Fornoff JE, Wolf SL, Wolfson LI, Buchner DM. A cross-sectional validation study of the FICSIT common data base static balance measures. Frailty and Injuries: Cooperative Studies of Intervention Techniques. *J Gerontol A Biol Sci Med Sci*. 1995;50(6):M291–7.
- Desrosiers J, Hebert R, Bravo G, Dutil E. Comparison of the Jamar dynamometer and the Martin vigorimeter for grip strength measurements in a healthy elderly population. *Scand J Rehabil Med*. 1995;27(3):137–143.
- Bohannon RW. Test-retest reliability of measurements of Hand-Grip Strength obtained by Dynamometry from older adults: a systematic review of Research in the PubMed Database. *J Frailty Aging*. 2017;6(2):83–7.
- Roberts HC, Denison HJ, Martin HJ, Patel HP, Syddall H, Cooper C, et al. A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardised approach. *Age Ageing*. 2011;40(4):423–9.
- von Wagner C, Knight K, Steptoe A, Wardle J. Functional health literacy and health-promoting behaviour in a national sample of british adults. *J Epidemiol Community Health*. 2007;61(12):1086–90.
- Kim JC, Chon J, Kim HS, Lee JH, Yoo SD, Kim DH, et al. The Association between fall history and physical performance tests in the Community-Dwelling Elderly: a cross-sectional analysis. *Ann Rehabil Med*. 2017;41(2):239–47.
- Folkman S, Lazarus RS. The coping process: an alternative to traditional formulations. *Stress: Springer Co.*; 1984. pp. 141–221.
- Vriezেকolk JE, van Lankveld WG, Eijssbouts AM, van Helmond T, Geenen R, van den Ende CH. The coping flexibility questionnaire: development and initial validation in patients with chronic rheumatic

- diseases. *Rheumatol Int*. 2012;32(8):2383–91.
25. Wettstein M, Wahl H, Heyl V. Assimilative and accommodative coping in older adults with and without sensory impairment: four-year change and prospective relations with affective well-being. 2019;23(9):1255–62.
 26. Sorensen K, Van den Broucke S, Fullam J, Doyle G, Pelikan J, Slonska Z, et al. Health literacy and public health: a systematic review and integration of definitions and models. *BMC Public Health*. 2012;25(12):80–2458.
 28. Weiss BD, Mays MZ, Martz W, Castro KM, DeWalt DA, Pignone MP, et al. Quick assessment of literacy in primary care: the newest vital sign. *Ann Fam Med*. 2005;3(6):514–22.
 29. Panel on Prevention of Falls in Older Persons, American Geriatrics Society and British Geriatrics Society. Summary of the Updated American Geriatrics Society/British Geriatrics Society clinical practice guideline for prevention of falls in older persons. *J Am Geriatr Soc*. 2011;59(1):148–157.
 30. Johnston MC, Crilly M, Black C, Prescott GJ, Mercer SW. Defining and measuring multimorbidity: a systematic review of systematic reviews. *Eur J Public Health*. 2019;29(1):182–189.
 31. Garson GD. Hierarchical Linear modeling: guide and applications; pages 3–26. Thousand Oaks: SAGE Publications, Inc; 2022.
 32. Nightingale CJ, Mitchell SN, Butterfield SA. Validation of the timed up and go test for assessing balance variables in adults aged 65 and older. *J Aging Phys Act*. 2019;27(2):230–3.
 33. Arvandi M, Strasser B, Meisinger C, Volaklis K, Gothe RM, Siebert U, et al. Gender differences in the association between grip strength and mortality in older adults: results from the KORA-age study. *BMC Geriatrics*. 2016;16(1):201.
 35. Jakobsen JC, Gluud C, Wetterslev Jø, Winkel P. When and how should multiple imputation be used for handling missing data in randomised clinical trials – a practical guide with flowcharts. *BMC Med Res Methodol*. 2017;17(1):162.
 36. Garson GD. Cluster analysis. Asheboro: Statistical Associates Publishers; 2012.
 37. Ward JH. Hierarchical grouping to optimize an objective function. 1963;58(301):236–44.
 38. Guojun G, Chaoqun M, and Jianhong W. Data Clustering. *Data Clustering: Theory, Algorithms, and Applications U.S.: Society for Industrial and Applied Mathematics*; 2007. p. 3–17.
 39. Cuevas-Trisan R. Balance Problems and Fall Risks in the Elderly. *Phys Med Rehabil Clin N Am*. 2017;28(4):727–737.
 40. Lehnert T, Heider D, Leicht H, Heinrich S, Corrieri S, Lupp M, et al. Review: health care utilization and costs of elderly persons with multiple chronic conditions. *Med Care Res Rev*. 2011;68(4):387–420.
 41. Huang CH, Lai Y, Lee YC, Teong XT, Kuzuya M, Kuo K. Impact of health literacy on Frailty among Community-Dwelling seniors. *Journal of Clinical Medicine*. 2018;7(12):481.
 42. Liang J, Bennett JM, Shaw BA, Quinones AR, Ye W, Xu X, et al. Gender differences in functional status in middle and older age: are there any age variations? *J Gerontol B Psychol Sci Soc Sci*. 2008;63(5):S282–92.
 43. Berkman ND, Sheridan SL, Donahue KE, Halpern DJ, Crotty K. Low health literacy and health outcomes: an updated systematic review. *Ann Intern Med*. 2011;155(2):97–107.
 44. Guojun G, Chaoqun M, Jianhong W. Hierarchical Clustering Techniques. *Data Clustering: Theory, Algorithms, and Applications U.S.: Society for Industrial and Applied Mathematics*; 2007. p. 109–149.
 45. Guojun G, Chaoqun M, Jianhong W. Scale Conversion. *Data Clustering: Theory, Algorithms, and Applications U.S.: Society for Industrial and Applied Mathematics*; 2007. p. 25–41.
 46. 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):142–8.
 47. Schoene D, Wu SM, Mikolaizak AS, Menant JC, Smith ST, Delbaere K, et al. Discriminative ability and predictive validity of the timed up and go test in identifying older people who fall: systematic review and meta-analysis. *J Am Geriatr Soc*. 2013;61(2):202–8.
 48. Guojun G, Chaoqun M, Jianhong W. Scale Conversion. *Data Clustering: Theory, Algorithms, and Applications U.S.: Society for Industrial and Applied Mathematics*; 2007. p. 25–41.
 49. van Bijsterveld SC, Barten JA, Molenaar EALM, Bleijenberg N, de Wit NJ, Veenhof C. Psychometric evaluation of the Decision Support Tool for Functional Independence in community-dwelling older people. *J Popul Ageing*. 2022:1–23.
 50. Constand MK, MacDermid JC, Dal Bello-Haas V, Law M. Scoping review of patient-centered care approaches in healthcare. *BMC Health Serv Res*. 2014;14:271–6963.

Chapter 5

Psychometric Evaluation of the Decision Support Tool for Functional Independence in Community-Dwelling Older People

Sander van Bijsterveld, Di-Janne Barten, Esther Molenaar,
Nienke Bleijenberg, Niek de Wit, Cindy Veenhof

Journal of Population Ageing

DOI: 10.1007/s12062-022-09361-x

ABSTRACT

Background: The aging population is increasingly faced with daily life limitations, threatening their Functional Independence (FI). These limitations extend different life domains and require a broad range of community-care professionals to be addressed. The Decision Support Tool for Functional Independence (DST-FI) facilitates community-care professionals in providing uncontradictory recommendations regarding the maintenance of FI in community-dwelling older people. The current study aims to determine the validity and reliability properties of the DST-FI.

Methods: Sixty community-care professionals completed a twofold assessment. To assess construct validity, participants were asked to assign predefined recommendations to fifty cases of older people to maintain their level of FI. Hypotheses were tested regarding the expected recommendations per case. Content validity was assessed by questions on relevance, comprehensiveness, and comprehensibility of the current set of recommendations. Twelve participants repeated the assessment after two weeks to enable both intra- and interrater reliability properties, expressed by an Intraclass Correlation Coefficient.

Results: Seven out of eight predefined hypotheses confirmed expectations, indicating high construct validity. As the recommendations were indicated 'relevant' and 'complete', content validity was high as well. Intra-rater reliability was poor to moderate while interrater reliability was moderate to excellent, resulting in moderate overall reliability.

Conclusion: The DST-FI suggests high validity and moderate reliability properties when used in a population of community-dwelling older people. The tool could facilitate community-care professionals in their task to preserve FI in older people. Future research should focus on psychometric properties like feasibility, acceptability, and developing and piloting strategies for implementation in community-care.

Keywords: Functional Independence · Psychometric Evaluation · Ageing · Community-Care · Older People · Prevention

INTRODUCTION

With the population aged 65 and over growing faster than all other age groups, the world's population is ageing. By the year 2050, one in four people living in North America and Europe is expected to be aged 65 or over (1). With 26% of its inhabitants expected to be over 65 years of age by the year 2040, the country of the Netherlands is no exception to this international trend (2). As age rises, so do impairments that hinder functioning in daily life. The Dutch National Institute for Public Health and the Environment estimated that in two decades, one in every three inhabitants will suffer from at least two chronic conditions (3). The ageing population, the rising demand for care, and the decreasing number of informal caregivers will challenge both Dutch society and its healthcare system for at least the next twenty years (2). To manage those challenges, a different approach has been implemented over the last years. This approach follows the renewed definition of health, which aims for maintaining capabilities and independence, instead of mainly focusing on curing chronic diseases. (4). The combination of this more holistic view on health and the future healthcare challenges will have the focus of healthcare shift increasingly towards maintaining and facilitating older people as 'functionally independent' as long as possible (4-6).

The definition of functional independence has first been described by Kidd et al. in 1995 (7). The current study uses the revised definition (8) for Functional Independence (FI) in community-dwelling older people as "Functioning physically safe and independent from other persons, within one's own context" (8). The construct of FI comprises a complex interaction of both individual and social domains. In addition to physical capacity, empowerment, coping, health literacy and actual behavior act like building blocks that coherently with contextual factors add up to the construct of FI. Previous research has identified the most influential factors and has established four profiles representing distinct and gradually decreasing levels of FI (9). The characteristics of each profile are shown in figure 1. For instance, the profile of the 'Well Literated' older people distinguishes itself by having above-average health literacy. Older people belonging to the 'Achievers' profile stand out for having relatively good physical capacity. The older people related to the 'Good Copers' profile stand out for well-developed coping strategies, despite their inferior physical capacity and health literacy. Finally, older people representing the 'Receivers' profile have poor scores on most of the domains of FI. Similarly, the 'Receivers' receive the greatest amount of professional support from healthcare professionals, more so than the other profiles. In short, as the characteristics of each profile of FI differ, so do the required community-care professionals needed for maintaining FI. Moreover, as FI reflects a multidimensional construct, professional support will often transcend the expertise of one particular professional. Although all community-care professionals may be considered capable of getting a first impression of an older adult's level of FI, specific expertise is needed to support such an adult adequately. For example, a physical therapist or movement coach could be involved for physical capacity impairments. The social worker or welfare worker might be relevant for coping challenges. Professionals such as the general practitioner, practice-nurse, dietician or district nurse could support health literacy in a positive way. Lastly, among others, the occupational therapist and physical therapist might be of added value for people that often fall (10). Ultimately, FI can rather be

interpreted as an interdisciplinary responsibility calling for interdisciplinary collaboration. However, at this moment, interdisciplinary collaboration seems to be insufficient, as current community-care has older people sometimes receive different or even contradictory advice, depending on the healthcare professional they visit.

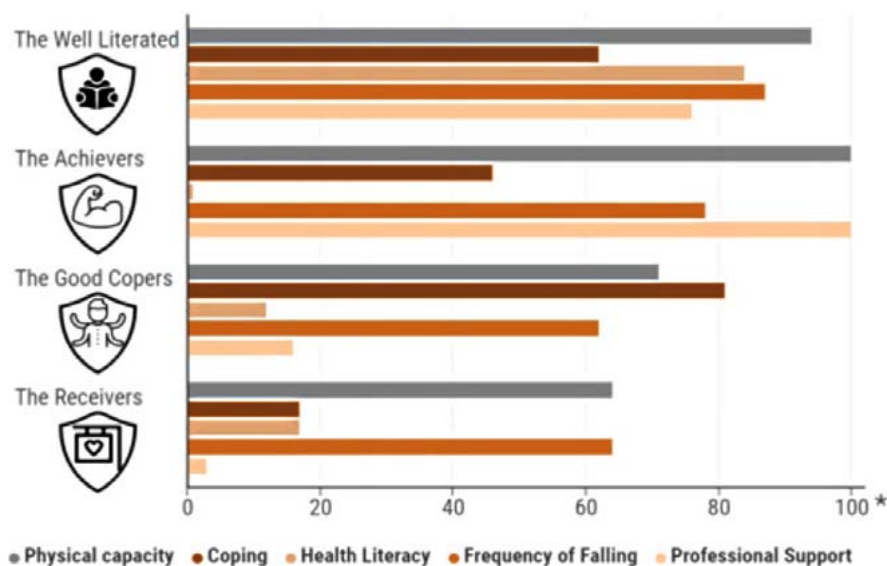


Fig. 1 Characteristics of Profiles of Functional Independence. Note. * Figure indicating the percentage of people within each profile that score above cut-of-points for every outcome. A low percentage on Frequency of Falling implies more people within that profile recently fell. A low percentage on Professional Support implies more people within that profile receive some form of care

Improved interdisciplinary collaboration regarding the maintenance of FI in community-dwelling older people requires a semantic unification among all the participants in the community-care playing field (11). Improving the unity in language between healthcare professionals and narrowing gaps in knowledge on each specific healthcare professional could be accomplished by using a co-created, generally accepted tool that represents all relevant interdisciplinary views. In short, a tool is needed to provide healthcare professionals, especially community-care professionals, with recommendations regarding maintaining FI in community-dwelling older people. Prior research has shown that decision-making tools or decision-making trees can support transparency in clinical decisions, improve the delivery of personalized care and improve adherence to standards of care (12-14). Moreover, those tools have proven to be especially useful when multiple areas of expertise are included since it promotes shared decision-making (15,16). Given the evidence and need to support community-care professionals who aim to preserve FI in community-dwelling older people, the Decision Support Tool for Functional Independence (DST-FI) was recently developed in co-creation with potential users of this tool (e.g. community-care professionals) (10). The DST-FI aims to assist community-care professionals by providing uncontradictory recommendations regarding

what older people need for preserving their level of FI. This tool covers all interdisciplinary aspects of FI and can be used by a broad range of community-care professionals. Figure 2 graphically outlines the mechanism of action of the DST-FI.

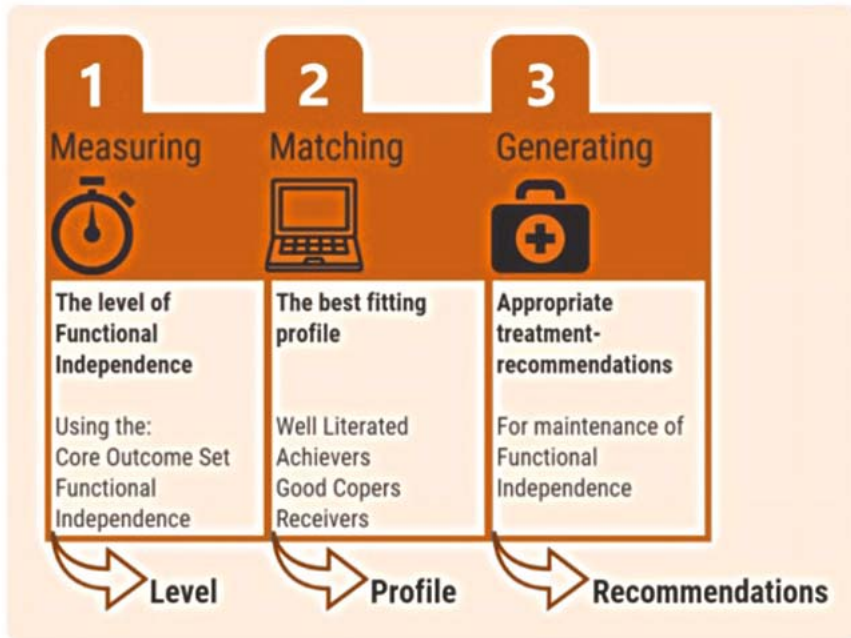


Fig 2 Mechanism of action of the Decision Support Tool for Functional Independence

The content of the DST-FI has been established by way of representative interdisciplinary focus groups and, subsequently, a consensus meeting (10). A more extended, external validation of these treatment-recommendations to be used by community-care professionals to preserve the level of FI in community-dwelling older people, is currently lacking. In order to use the DST-FI as both a valid and clinically relevant tool in a broad population of Dutch community-care professionals, psychometric evaluation of the DST over a wide spectrum of community-care professionals is required. Knowledge of validity and reliability measures is expected to promote the use and implementation of the DST-FI for the assessment of FI in community-dwelling older people (17).

Therefore, the objective of this study was to assess validity and reliability of the Decision Support Tool for Functional Independence (DST-FI) when used by community-care professionals in order to provide personalized recommendations regarding maintaining FI in community-dwelling older people, above 65 years of age.

METHODS

Study design

A cross-sectional descriptive psychometric evaluation study was conducted to determine the validity and reliability of the DST-FI (Part III) when used by community-care professionals in a population of community-dwelling older people. More specifically, this study focused on assessing content-validity, construct-validity, inter-professional reliability in several community-care professionals. Lastly, intra-professional reliability was determined particularly for physical therapists as they are the leading professionals in maintaining FI in community-dwelling older people.

This study followed, where applicable, the guidelines of the Consensus-based Standards for the selection of health Measurement Instruments (COSMIN-initiative) (18).

Population

Participants were community-care professionals involved in attaining and sustaining the health of community-dwelling older people in the Netherlands. Since FI is an interdisciplinary construct, different types of health professionals were invited to ensure a broad psychometric evaluation of the DST-FI. Participants needed to either act as a general practitioner, practice-nurse, physical therapist, occupational therapist or as a district nurse. Exclusion criteria were; insufficiently digitally skilled, insufficient knowledge of the Dutch language or having no access to a laptop or pc with an internet connection.

The intended sample size of this psychometric study reflected the recommendations of the COSMIN initiative, thus aiming to analyze data of more than fifty community-care professionals to acquire adequate psychometric measures (18). As physical functioning is a key domain of FI, recruitment specifically focused on physical therapists (8). Potential participants were approached by contacting professional-associations, community-care practices and individual professionals throughout the Netherlands. Recruitment took place via email, phone calls, and social media posts, in March and April of 2020. The originally planned on-site recruitment through presentations of the project leader was not possible due to social-distance regulations during the COVID-19 pandemic (19). Therefore, online flyers were distributed instead.

Explanatory – Decision Support Tool Functional Independence

The DST-FI comprises three subsequent parts. The first part concerns the measurement of older people's level of FI by way of the Core Outcome Set Functional Independence (COSFI). The COSFI covers seven commonly used validated instruments and represents all separate domains of FI. The COSFI has shown to be able to distinguish between different levels of FI (20). In addition to the COSFI, insight into the received level of professional caregiver support was acquired, and a screening of history of falling was performed. In the second part of the DST-FI, an older person will be matched to one of four profiles of FI, based on dichotomized outcomes of the COSFI. The profile which matches the most to an older person's COSFI scores will be adopted. The third and final part of the DST-FI comprises generating appropriate treatment recommendations based on the profile assigned in step two, which could then be used by community-care professionals. An example of such a generated recommendation contains the involvement of an occupational therapist.

Study procedures

The complete procedure of this study was graphically outlined in figure 3. All participants were asked to perform a one-time, online assessment consisting of two parts.

In the first part, participants were asked to recommend which community-care professionals should be involved in treating fifty unique cases of older people. These cases represented community-dwelling older people who have previously undergone COSFI-testing (20). In the context of the current study, these cases of community-dwelling older people were anonymized¹. To ensure participants were able to form a picture of each older adult, every case of older adults comprised demographic data and information on the older people's level of FI. More specifically, the following demographics were given: age (years), sex (male/ female), and living situation (alone/ with partner/ in a residential care center). Furthermore, information on the different domains of FI (physical capacity, health literacy, coping, frequency of falling and professional support) was given on a 3-point scale; either below average, average, or above average. See Appendix 1 for an example case of the online assessment. Based on this information, participants were asked to recommend a minimum of one and a maximum of four pre-defined community-care professionals that most suited the needs of each specific case. Participants selected up to four but did not need to put them into order. For example: when participants wanted only one professional to be involved, they needed to select 'no further recommendations' three times for analytical purposes. Possible community-care professionals to be recommended were: general practitioner, practice-nurse, district nurse, occupational therapist, physical therapist, welfare worker, movement coach, an interdisciplinary community-care team or a dietician.

In the second part of the assessment, participants completed questions on the relevance, comprehensiveness, and comprehensibility of the pre-defined set of community-care professionals

1. The study described by Dockx et al. has obtained written informed consent from participants to join in the overarching research project. Ethics approval was performed by the ethical committee of the Utrecht University of Applied Sciences (Ref nr. 85-000-2019).

(the recommendations) to be involved. For relevance, participants were asked to assign social roles to each professional that could be chosen during the first part of the assessment. Roles to choose from were: identify, initiate, execute, refer, and coordinate. Each professional could have multiple roles assigned. For comprehensiveness, participants were asked whether the current set of recommendations was complete. They answered on a five-point Likert scale (very incomplete, incomplete, mediocre, complete, very complete). Lastly, for comprehensibility of the response set, participants were asked which potentially involved professionals they would like to be added to the set. Furthermore, participants had the chance to make comments on the procedure of assigning community-care professionals to cases based on FI deficiencies.

In addition to the primary assessment, for intra-rater reliability purposes, participants working as physical therapists were again asked to recommend which community-care professionals should be involved in maintaining older people's FI. Instead of the complete set of fifty unique cases of older people, physical therapists completed the repeating assessment for the first 25 cases of the prior assessment. A minimum sample of 22 measurement units is required to determine an ICC of >0.5 (21). On top of that, a short questionnaire decreases the probability of missing data and thus was a pragmatic choice as well. The online assessment was pilot-tested by community-care professionals and physical therapy students before the data collection took place. During this phase, the form was tested on clarity, interim saving, and time-to-complete (22). The main findings of the pilot-testing were: unclear instructions on the assignment and inadequate description of the community-care professionals whose involvement could be recommended. Due to the COVID-19 restrictions, data-collection proceeded exclusively online.

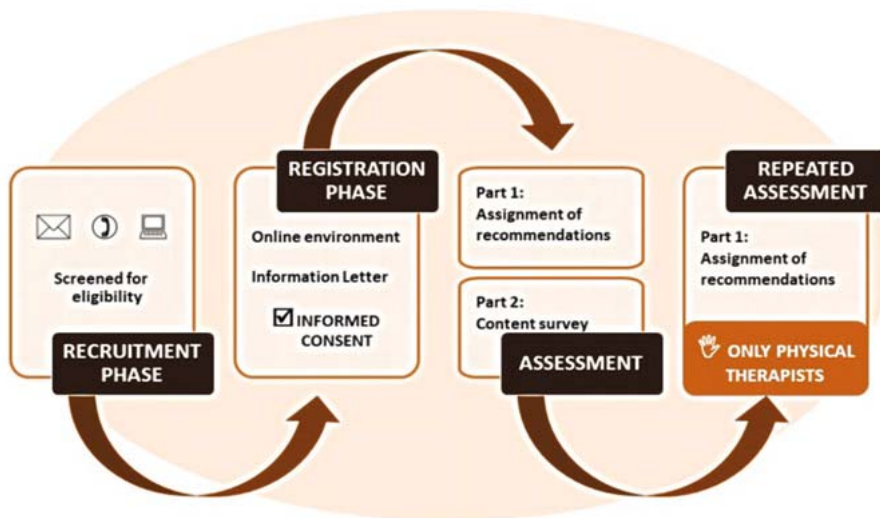


Fig 3 Flowchart of Study Procedures

Outcomes

Outcomes of this study were four psychometric properties, priorly defined by the COSMIN group (23).

Construct validity

In the light of the DST-FI, *construct validity* refers to the degree to which treatment-recommendations generated by the DST-FI reflect the recommendations provided by the study participants. Assessing construct validity requires a-priori stated hypotheses about differences between groups to be tested. In this study, eight hypotheses were defined a-priori by the research team through a consensus meeting. These hypotheses were based on the characteristics of the four profiles (see table 1) and included the expected direction of differences in recommended professionals to be involved per profile. Construct validity is considered 'good' when more than 50% of predefined hypotheses are confirmed (24).

Table 1 Hypotheses regarding the expected distribution of recommended professionals to maintain functional independence in older people

Expected (direction of) differences	Motivation
... the Achievers will receive more recommendations concerning the social worker than the Well Literated	Their lower health literacy
... the Good Copers will receive more recommendations concerning an occupational therapist than the Well Literated	Their higher frequency of falling
... the Well Literated will receive more recommendations concerning the movement coach than the Achievers	Their slightly lower physical capacity
... the Receivers will receive more recommendations concerning the district nurse than the Achievers and the Well Literated	Their higher healthcare usage
... the Good Copers will receive more recommendations concerning a physical therapist than the Achievers	Their lower physical capacity
... the Receivers will receive more recommendations concerning a general practitioner than the Well Literated	Their higher healthcare usage and lower health literacy
... the Receivers will receive more recommendations concerning an occupational therapist than the Well Literated	Their higher frequency of falling
... the Receivers will receive more recommendations concerning the physical therapist than the Achievers	Their lower physical capacity

Content validity

Content validity covers the extent to which the current set of treatment-recommendations covers all domains of the FI-construct. The content validity of an instrument is made up of the degree of relevance, comprehensiveness, and comprehensibility (25). However, the current study focused solely on the content of the set of professionals that could be involved. This study had participants complete a survey on the quality of the set of recommendations used in the DST-FI (i.e. the possible community-care professionals that could be chosen to be involved). Survey results were judged resulting in a descriptive rating of the content validity (regarding relevance, comprehensiveness, and comprehensibility of the set of recommendations). In summary, the aim was to make an

objective description of whether participants agreed that the professionals incorporated in the DST adequately covered the treatment of older people with decreased FI.

Reliability

Reliability refers to the degree to which the recommended professionals differ between participants in this psychometric evaluation. The difference between participants is referred to as *interrater reliability* and the difference within participants over time is referred to as *intra-rater reliability* (23). The assessment of validity- and reliability measures of the DST-FI reflected the methodological guidelines of the COSMIN study design checklist (18). Assessing reliability measures required the results of individual participants to be compared. Briefly, if most participants independently from one another recommend more or less the same professionals to be involved, good reliability measures are to be expected (23). Assessment results of individual participants were compared per profile of FI. Therefore, recommended professionals to cases of the same profile were cumulated. For interrater reliability, the intraclass correlation coefficient (ICC) was used as a measure of similarity between participants (26). Interrater reliability was determined 1) between raters with the same profession and 2) between all raters. Both were determined in the assumption that interrater agreement limited to one profession would be greater than the agreement between the entire group of raters since they had different areas of expertise. Thereafter, intra-rater reliability was determined as ICC. The ICC ranges from 0 to 1 and uses the following classification: values <0.5 representing poor, 0.5-0.75 indicate moderate, 0.75-0.9 indicate good and values >0.9 indicate excellent reliability (26). As physical therapists are key professionals in maintaining FI in older people, these participants have been selected to determine intra-rater reliability.

Statistical analyses

Although only entirely completed assessments were used for further analysis, descriptive statistics were used to get insight into the number of participants that either attempted or completed the analysis. These statistics were then stratified per profession. Partially completed assessments could not be used since analytical methods required an assumption to be met stating that all participants needed to have an equal number of ratings performed for every case rated (26,27). Imputation of incomplete assessments was not suitable because all cases of older people were unique and their input contained multiple-response sets of answers (28). To get insight into which community-care professionals were recommended to get involved for each case, thus for each profile, multiple-response sets were defined and frequency tables were generated (29,30). Analysis for *construct validity* started with getting insight into whether or not significant deviations occurred in the distribution of recommendations between different profiles of FI. Pearson Chi-Square tests were used to test the null hypotheses of no relationship between profiles and assigned recommendations (31). To correct for multiple testing and get insight into the between-group differences, adjusted standardized residuals were acquired and used for post-hoc cellwise residual analysis (32). The Bonferroni-corrected significance values combined with multiple-response frequency tables provided the information needed to either confirm or reject the a-priori stated hypotheses. A

significance value of $\alpha = 0.05$ was used. Analysis for *content validity* started with describing answers to the survey's questions regarding relevance, comprehensiveness, and comprehensibility. Answers to the two open questions were recited using straightforward codebook analysis. The questions on completeness of the current set of possible professionals to be involved and on social roles to be assigned to each professional were analyzed using frequency cross-tables. Lastly, the output of all four questions was used for the descriptive rating of the content validity of the DST-FI (25). Analysis for *reliability* measures required the frequencies of individual community-care professionals recommended to each profile to be compared among all participants. The similarity in recommended professionals between participants was determined for all participants and per profession. For interrater reliability, a two-way random-effects model was used, and a consistency ICC was calculated (26). For intra-rater reliability, a two-way mixed-effects model was used, and an absolute agreement ICC was calculated, resulting in separate ICC values for each participant. (26). All data were analyzed using Statistical Package for the Social Sciences (SPSS version 26.0, IBM Inc., Armonk NY, USA).

Ethics

An online informed consent was collected by a checked-box prior to the online assessment. All personal data entered by participants was handled according to the rules of the General Data Protection Regulation (GDPR) (33).

RESULTS

Population

Recruitment resulted in 88 professionals participating in the online assessment. Due to not-at-random missing data, assessments of 60 participants were included for analyses. This group consisted of seven general practitioners, ten occupational therapists, seven practice-nurses, 23 physical therapists, and thirteen district nurses. All five professions had a completion rate of 71% to 87% except for the district nurses which had a completion rate of 45%. As intended, physical therapists were the best-represented group of participants with a total of 23 completed assessments. Moreover, twelve physical therapists repeated the (shortened) assessment two weeks after completion of the primary assessment to assess intra-rater reliability.

Construct validity

Table 2 shows absolute and relative frequencies of recommended professionals to be involved and the profiles to whom the assessed cases belonged. When a-priori stated hypotheses (see methods section) regarding the expected distribution of recommended professionals to profiles were compared with the findings in table 2, seven of the eight hypotheses were confirming expectations. Only hypothesis no. 3 concerning the distribution of movement coach recommendations was rejected, as shown in table 3. Bonferroni corrected Pearson Chi-square tests showed no significant differences regarding the recommendation of movement coach involvement among the four profiles.

Table 2 Comparison of proportions of assigned recommendations to cases in each profile of functional independence

Recommendations	The Well Literate (11 cases) N	Percent	The Achievers (10 cases) N	Percent	The Good Copers (19 cases) N	Percent	The Receivers (10 cases) N	Percent
No additional recommendations	1288	49*	877	37*	749	16*	162	7*
General practitioner	216	8*	216	9*	503	11	377	16*
Practice nurse	322	12	427	18*	612	13	328	14
Movement coach	123	5	123	5	188	4	103	4
Welfare worker	84	3	150	6*	126	3*	89	4
Social worker	131	5*	197	8*	279	6	171	7
Dietician	13	1*	55	2*	84	2	31	1
District nurse	200	8*	71	3*	858	19*	478	20*
Occupational therapist	111	4*	156	7*	475	10*	252	11*
Physical therapist	152	6*	128	5*	686	15*	409	17*
total	2640	100	2400	100	4560	100	2400	100

N = absolute number of recommendations. Totals differ because cases are not evenly distributed over the four profiles. An asterisk implies a profile-recommendation relationship that deviates significantly from 'no difference'.
Rounded to whole percentages.

Table 3 Overview of tested hypotheses regarding recommendations of professionals to cases of older people

Hypothesis	Confirmed
the Achievers will receive more recommendations concerning the social worker than the Well Literated	Yes
the Good Copers will receive more recommendations concerning an occupational therapist than the Well Literated	Yes
the Well Literated will receive more recommendations concerning the movement coach than the Achievers	No
the Receivers will receive more recommendations concerning the district nurse than the Achievers and the Well Literated	Yes
the Good Copers will receive more recommendations concerning a physical therapist than the Achievers	Yes
the Receivers will receive more recommendations concerning a general practitioner than the Well Literated	Yes
the Receivers will receive more recommendations concerning an occupational therapist than the Well Literated	Yes
the Receivers will receive more recommendations concerning the physical therapist than the Achievers	Yes

Content validity

Results of the survey on the quality of the response-set are shown in figure 4 and table 4. In terms of relevance, all professionals were assigned multiple roles by participants. The general practitioner was mostly seen as coordinator and referrer. As shown in figure 4, multiple professionals were seen as identifiers, initiators or as executors. For comprehensiveness, a total of 51 out of 60 participants reported that the current set of recommendations is either complete or very complete. Lastly, for comprehensibility, several suggestions for additional professionals to be recommended and case-related information to be included were given, as shown in table 4. For example, one participant has advised to make cognitive function part of the DST-FI and four participants have advised to include the psychologist as a recommendable professional.

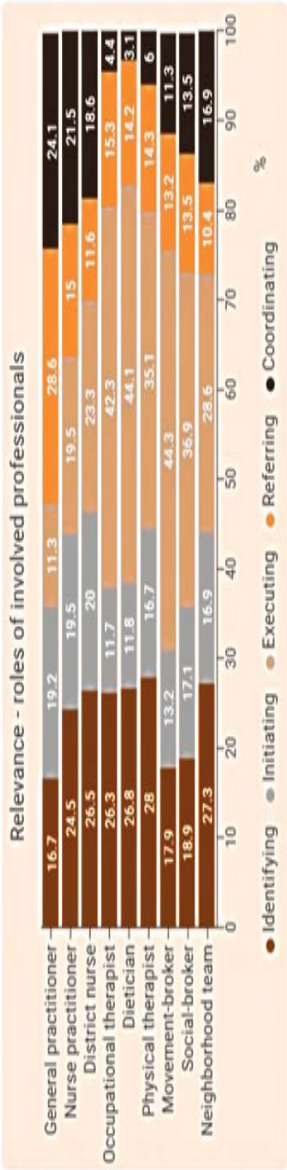


Fig 4 Content Validity of the set of involved professionals - Relevance

Table 4 Content Validity of the set of involved professionals to maintain functional independence in older people: Comprehensiveness and Comprehensibility

Table 4a		Table 4b	
Comprehensiveness - completeness of response-set		Comprehensibility - additions and comments	
Frequency	Percent	Suggestions for additional recommendations	
Very incomplete	0	Pharmacist (n=1)	
Incomplete	3.3	Case-manager dementia (n=4)	
Mediocre	11.7	Psychologist (n=3)	
Complete	70	Social worker (n=2)	
Very complete	15	Exercise therapist (n=1)	
Total	100	Information on comorbidities (n=2), body-composition (n=2) and cognitive function (n=1)	

Reliability

Reliability measures are shown in table 5. Interrater reliability coefficients were *poor to moderate* and the mean intra-rater reliability coefficient was *good*. All findings were statistically significant. Although the mean intra-rater coefficient was classified as *good*, individual values ranged from *moderate to excellent*.

Table 5 Reliability measures – intra- and interrater

Interrater Reliability						
Rater Group	Intraclass Correlation Coefficient	95% CI Lower Bound	95% CI Upper Bound	F Test	P-value	Agreement Classification
Overall Agreement (60 raters)	.520	.418	.643	66.025	<.000*	Moderate
General practitioners (7 raters)	.602	.480	.727	11.604	<.000*	Moderate
District nurses (13 raters)	.523	.409	.653	15.246	<.000*	Moderate
Practice-nurses (7 raters)	.656	.540	.769	14.347	<.000*	Moderate
Occupational therapists (10 raters)	.595	.480	.717	15.687	<.000*	Moderate
Physical therapists (23 raters)	.491	.384	.620	23.152	<.000*	Poor
Intra-rater Reliability						
N	Minimum	Maximum	Mean	Standard Deviation	Agreement Classification	
12	.637	.963	.839	.104	Moderate to Excellent	

N = absolute number of repeated assessments by physical therapists. An asterisk implies a significant finding.

DISCUSSION

This study aimed to assess the validity and reliability of the DST-FI (Part III) when used by community-care professionals in a population of community-dwelling older people. Overall, the DST-FI has high validity measures. Regarding construct validity, seven out of eight hypotheses stating expected differences in the distribution of recommended professionals were accepted. For content validity, the current set of recommendations was rated as relevant and complete. Lastly, reliability measures showed to be moderate. However, it has to be mentioned that profession-specific interrater and intra-rater sample sizes did not meet COSMIN standards required for obtaining adequate measures.

An unexpected finding concerned the construct validity of the DST-FI. As opposed to our expectation stated in hypothesis no. 3, the Achievers (physically strong, older people) were more often associated with a movement coach than people represented by the Well Literated profile (high health-literacy level). Participants might have selected the movement coach to be involved in some cases from a

preventive point of view. This corresponds to what is known about the role and context of movement coaches in The Netherlands, which states that the movement coach could help people maintain their level of physical activities (34,35). Unfortunately, movement coaches were not participating in the current study for clarification of this issue. Furthermore, these results may suggest that many older people do not yet need community-care professional involvement and can maintain or improve their level of FI themselves. Moreover, a regularly scheduled FI-check might help a considerable group of older people to prevent future healthcare costs.

Another interesting finding concerned the interrater reliability measures. Most are classified as moderate and are therewith in line with previous, comparable psychometric evaluation studies (12, 14). The interrater reliability in physical therapists however, as best represented group of participants and key players in maintaining FI in older people, appeared to be classified as poor. Unfortunately, it is difficult to explain these findings as we collected demographic data of the participants to a limited extent. In general, moderate scores on interrater reliability measures of the current study can be explained by several reasons. First and foremost, participants probably had different levels of experience and different areas of expertise. In addition, views on the added value of other, sometimes unknown professions might have differed among participants (36). Moreover, the exposed differences in views between different professionals may reflect everyday clinical practice and its barriers (37, 38). Differences in views between professionals do not disqualify the use of the DST-FI because the tool as a whole seems to reflect the community's view very well. Finally, the DST-FI will not replace the expertise of community-care professionals but facilitate their decision-making process, thus will always be used with a specific older adult in mind.

Regarding the content of the DST-FI, the pre-defined set of professionals to be involved was mostly rated as complete by the participating community-care professionals. Although participants suggested adding other professions to the set, current professions were all rated as relevant professions to treat older people with a (risk of) decreased level of FI. Furthermore, the current study shows each profile requires various professionals to get involved, therewith providing evidence for the interdisciplinary character of the construct of FI. This resembles previous studies stressing the importance of a multidisciplinary approach in the care for community-dwelling older people (39-41).

Strengths and Limitations

A strength of this study was the inclusion of a very diverse group of community-care professionals ensuring a wide clinical view on how to facilitate community-dwelling older people in maintaining their FI. Spread over five professions, sixty participants have completed the assessment which, according to COSMIN is an adequate representation. The proportion of physical therapists was quite higher than the other professionals. Although this may have influenced the outcome of the assignments, it does reflect the situation in clinical practice. Physical therapists are key players in maintaining FI in community-dwelling older people. For that reason, we did not account for the overrepresentation of physical therapists in our sample of community-care professionals.

Furthermore, it should be mentioned that the completion rate was quite lower in the group of district nurses compared to the other groups of participants. This could be a consequence of the timing of the data-collection: COVID-19 had just made its appearance, which increased the workload of specifically district-nurses largely. Another strength comprised the applied procedure of psychometric evaluation. Psychometric evaluation of the DST-FI applied a rigorous procedure of testing eight priorly stated hypotheses that contained the expected direction of the results when comparing the different profiles of FI.

This study had some limitations that need to be considered. First and foremost, the hypotheses on expected differences in recommendations assigned to cases of the four profiles of FI only included the direction of expected differences between these profiles, whereas COSMIN calls for hypotheses including both a direction and a magnitude. Despite that we tried to argue specific magnitudes using existing data on characteristics per profile of FI, determining the magnitude of expected differences failed. Although cases within the same profile were similar in their shortcomings, they were not identical. Therefore, specific statements on the magnitude of inter-profile differences in recommendations assigned were nearly impossible to sufficiently substantiate. Further, the limited personal- and contextual information shown in the case description during the online assessment may have been a limitation in this study. By way of illustration, participants were able to recommend a dietician to get involved although they had no information on comorbidities, bodyweight or body-mass-index (BMI) of a specific case. Similarly, information on cognitive functioning was not given, despite cognitive function is known to have impact on an older adult's level of FI (42). Related to this, mental health professionals, such as a psychologist or case-manager dementia, may be added to the current set of recommendable professionals in an updated version of the DST-FI. Furthermore, the fact that no demographics of participating professionals were collected other than their profession, limits the ability to make statements on differences in their views. In hindsight, factors as age, sex, years of practice and workplace (rural or urban) might have explained some of the differences found, such as the poor interrater reliability measures in physical therapists. Data about these demographics could also have provided insight into the generalizability of the study findings.

Recommendations

In this study, the DST-FI seems to be an appropriate instrument to adequately generate broadly-based recommendations regarding the involvement of community-care professionals to maintain FI in community-dwelling older people with a (risk of) decreased level of FI. However, several recommendations should be considered before starting to use the DST-FI in clinical practice.

First, although a moderate reliability trend held true for reliability in individual professions, sample sizes were too small to obtain adequate results. Therefore future studies on specific professionals are needed to confirm the findings of the current study. Secondly, in response to participants that advised to incorporate more information and additional community-care professionals, the current scope of health domains of the DST-FI could be enriched. For instance, additional information that

provides insight into body composition could aid the DST-FI in adequately recommending a dietitian (43, 44). Similarly, if information on cognitive function would be given, this could assist the DST-FI in recommending a psychologist or case-manager dementia when required to sustain FI (45-47). On the other hand, the community-care professional using the DST-FI will usually have more information about their client than just the recommendations generated by the DST-FI. Thirdly, to ensure optimal applicability of the DST-FI, future research could focus on investigating the most feasible mode of use. Perhaps a digitally approachable form with a user-friendly graphical user interface will ease the use in clinical practice and enlarge opportunities for updating the DST-FI in the future (48). Aside from feasibility, acceptability, and small-scale pilot testing should be considered. Moreover, the subsequent implementation process should involve several community-care professionals. Similar to the stages of development and validation, having a broad group of professions and older people themselves will benefit implementation in the care for community-dwelling older people (49). Fourthly, although the current study provides considerable evidence for DST-FI usage in community-care, all participants were community-care professionals already involved in attaining and sustaining the health of community-dwelling older people. Therefore, further research should focus on assessing feasibility among a more diverse, group of community-care professionals who are less frequently involved in the care for older people. Ultimately, if the DST-FI proves to be suitable for professionals with varying experience working with community-dwelling older people, the DST will be of great value for the growing aging population.

Conclusion

The DST-FI is suggested to be a highly valid and moderately reliable tool to generate treatment-recommendations regarding the maintenance of FI in community-dwelling older people. Future research is recommended on confirming the current result in larger samples of community-care professionals. To optimize its use in clinical practice, future research may be focused on widening the scope of included health-domains, assessing feasibility in less experienced community-care professionals and developing a user-friendly mode of use.

REFERENCES

- United Nations. Ageing | United Nations. In: Global Issues - Ageing. 2019. Available from: <https://www.un.org/en/sections/issues-depth/ageing/> [Accessed 27 Feb 2021].
- Rijksinstituut voor Volksgezondheid en Milieu (RIVM). Volksgezondheid Toekomst Verkenning. In: VTV-2018. 2018. Available from: <https://www.vtv2018.nl/zorguitgaven> [Accessed 19 Sep 2019].
- National Institute for Public Health and the Environment. Synthese | Volksgezondheid Toekomst Verkenning. 2018. Available from: <https://www.vtv2018.nl/synthese> [Accessed 10 Mar 2020].
- Huber M, Knottnerus JA, Green L, et al. How should we define health? *BMJ*. 2011;343:d4163. <https://doi.org/10.1136/bmj.d4163>
- Government of the Netherlands. Rapport 'de Juiste Zorg op de Juiste Plek'. 2018. Available from: <https://www.dejuistezorgopdejuisteplek.nl/over-ons/documenten/rapporten/2018/4/1/taskforce-rapport> [Accessed 22 Oct 2019].
- World Health Organization. Integrated care for older people. Geneva: WHO; 2019.
- Kidd D, Stewart G, Baldry J, et al. The functional independence measure: A comparative validity and reliability study. *Disabil Rehabil*. 1995;17(1):10–14. <https://doi.org/10.3109/09638289509166622>
- Molenaar EALM, Barten JA, te Velde S, et al. Functional Independence in the Community Dwelling Older People: a Scoping Review. *J Popul Ageing*. 2020:1–20. <https://doi.org/10.1007/s12062-020-09315-1>
- Molenaar EALM, Barten D, Veenhof C. Profiles in Functional Independence in community-dwelling Dutch older adults. In progress; 2020.
- Molenaar EALM, Barten D-J, Veenhof C. Development of the Decision Support Tool for Functional Independence of community-dwelling older adults. In progress; 2020.
- Sangaletti C, Schweitzer MC, Peduzzi M, et al. Experiences and shared meaning of teamwork and interprofessional collaboration among health care professionals in primary health care settings: a systematic review. *JBI Database System Rev Implement Rep*. 2017;15(11):2723–88. <https://doi.org/10.11124/JBISIR-2016-003016>
- Qin Z, Armijo-Olivo S, Woodhouse LJ, Gross DP. An investigation of the validity of the Work Assessment Triage Tool clinical decision support tool for selecting optimal rehabilitation interventions for workers with musculoskeletal injuries. *Clin Rehabil*. 2016;30(3):277–87. <https://doi.org/10.1177/0269215515578696>
- Graham MM, James MT, Spertus JA. Decision Support Tools: Realizing the Potential to Improve Quality of Care. *Can J Cardiol*. 2018;34(7):821–6.
- Butera KA, George SZ, Lentz TA. Psychometric evaluation of the Optimal Screening for Prediction of Referral and Outcome Yellow Flag (OSPRO-YF) Tool: Factor Structure, Reliability, and Validity. *J Pain*. 2019. <https://doi.org/10.1016/j.jpain.2019.09.003>
- Manca DP, Campbell-Scherer D, Aubrey-Bassler K, et al. Developing clinical decision tools to implement chronic disease prevention and screening in primary care: The BETTER 2 program (building on existing tools to improve chronic disease prevention and screening in primary care). *Implement Sci*. 2015;10:107. <https://doi.org/10.1186/s13012-015-0299-9>
- Davies N, Schiowitz B, Rait G, et al. Decision aids to support decision-making in dementia care: A systematic review. *Int Psychogeriatr*. 2019;31(10):1–17.
- Lai PSM. Validating instruments of measure: Is it really necessary? *Malays Fam Physician*. 2013;8(2):2–4.
- Mokkink LB, Prinsen CAC, Patrick DL, et al. COSMIN Study Design checklist for Patient-reported outcome measurement instruments. Amsterdam: Amsterdam Public Health Research Institute, VU Medical Center; 2019.
- National Institute for Public Health and the Environment. Novel coronavirus (COVID-19) | RIVM. 2020. Available from: <https://www.rivm.nl/en/novel-coronavirus-covid-19> [Accessed 28 Mar 2020].
- Dockx YJC, Molenaar EALM, Barten DJJA, Veenhof C. Discriminative validity of the Core outcome set functional independence in a population of older adults. *BMC Geriatr*. 2020;20:309. <https://doi.org/10.1186/s12877-020-01705-6>
- Bujang MA. A simplified guide to determination of sample size requirements for estimating the value of intraclass correlation coefficient: A review. *Arch Orolfac Sci*. 2017;12:1–11.
- De Vet HCW, Terwee CB, Mokkink LB, Knol DL. Measurement in medicine: A practical guide. Cambridge: Cambridge University Press; 2011.
- Mokkink LB, Terwee CB, Patrick DL, et al. The COSMIN study reached international consensus on taxonomy, terminology, and definitions of measurement properties for health-related patient-reported

- outcomes. *J Clin Epidemiol.* 2010;63(7):737–45. <https://doi.org/10.1016/j.jclinepi.2010.02.006>
24. Mokkink LB, de Vet HCW, Prinsen CAC, et al. COSMIN Risk of Bias checklist for systematic reviews of Patient-Reported Outcome Measures. *Qual Life Res.* 2018;27(5):1171–9. <https://doi.org/10.1007/s11136-017-1765-4>
 25. Terwee CB, Prinsen CA, Chiarotto A, et al. COSMIN methodology for assessing the content validity of PROMs: User manual. *Circulation.* 2018;120:0–70.
 26. Koo TK, Li MY. A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research. *J Chiropr Med.* 2016;15(2):155–63. <https://doi.org/10.1016/j.jcm.2016.02.012>
 27. Landers R. Computing Intraclass Correlations (ICC) as Estimates of Interrater Reliability in SPSS. *The Winnower.* 2015;1–4. <https://doi.org/10.15200/winn.143518.81744>
 28. Jakobsen JC, Gluud C, Wetterslev J, Winkel P. When and how should multiple imputation be used for handling missing data in randomised clinical trials - A practical guide with flowcharts. *BMC Med Res Methodol.* 2017;17:162. <https://doi.org/10.1186/s12874-017-0442-1>
 29. Miller RL, Acton C, Fullerton DA, et al. Multiple Response Sets. In: *SPSS for Social Scientists.* London: Macmillan Education UK; 2002. p. 217–38.
 30. Miller RL, Acton C, Fullerton DA, Maltby J. *SPSS for Social Scientists.* London: Macmillan Education UK; 2002.
 31. Beasley TM, Schumacher RE. Multiple regression approach to analyzing contingency tables: Post hoc and planned comparison procedures. *J Exp Educ.* 1995;64(1):79–93. <https://doi.org/10.1080/00220973.1995.9943797>
 32. García-Pérez MA, Núñez-Antón V. Cellwise Residual Analysis in Two-Way Contingency Tables. *Educ Psychol Meas.* 2003;63(5):825–39. <https://doi.org/10.1177/0013164403251280>
 33. Van Alsenoy B. General Data Protection Regulation. In: *Data Protection Law in the EU: Roles, Responsibilities and Liability.* 2019. p. 279–324.
 34. Leenaars KEF, Smit E, Wagemakers A, et al. The role of the care sport connector in the Netherlands. *Health Promot Int.* 2018;33(3):422–35. <https://doi.org/10.1093/heapro/daw097>
 35. Leenaars KEF, van der Velden-Bollemaat EC, Smit E, et al. The operational context of care sport connectors in the Netherlands. *Health Promot Int.* 2018;33(4):622–34. <https://doi.org/10.1093/heapro/dax005>
 36. Kozłowski D, Hutchinson M, Hurley J, et al. The role of emotion in clinical decision making: an integrative literature review. *BMC Med Educ.* 2017;17:255. <https://doi.org/10.1186/s12909-017-1089-7>
 37. O'Reilly P, Lee SH, O'Sullivan M, et al. Assessing the facilitators and barriers of interdisciplinary team working in primary care using normalisation process theory: An integrative review. *PLoS One.* 2017;12(5):e0177026.
 38. Doekhie KD, Buljac-Samardzic M, Strating MMH, Paauwe J. Who is on the primary care team? Professionals' perceptions of the conceptualization of teams and the underlying factors: A mixed-methods study. *BMC Fam Pract.* 2017;18:111. <https://doi.org/10.1186/s12875-017-0685-2>
 39. Tanaka M. Multidisciplinary team approach for elderly patients. *Geriatr Gerontol Int.* 2003;3(2):69–72. <https://doi.org/10.1046/j.1444-1586.2003.00074.x>
 40. Goodman C, Drennan V, Scheibl F, et al. Models of inter professional working for older people living at home: A survey and review of the local strategies of English health and social care statutory organisations. *BMC Health Serv Res.* 2011;11:337.
 41. Trivedi D, Goodman C, Gage H, et al. The effectiveness of inter-professional working for older people living in the community: A systematic review. *Health Soc Care Community.* 2013;21(2):113–28.
 42. Dodge HH, Du Y, Saxton JA, Ganguli M. Cognitive Domains and Trajectories of Functional Independence in Nondemented Elderly Persons. *J Gerontol A Biol Sci Med Sci.* 2006;61(12):1330–7. <https://doi.org/10.1093/gerona/61.12.1330>
 43. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, et al. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. *Age Ageing.* 2010;39(4):412–23. <https://doi.org/10.1093/ageing/afq034>
 44. Morley JE. Frailty and sarcopenia in elderly. *Wien Klin Wochenschr.* 2016;128(7–8):439–45. <https://doi.org/10.1007/s00508-016-1087-5>
 45. MacNeill SE, Lichtenberg PA. Home alone: The role of cognition in return to independent living. *Arch Phys Med Rehabil.* 1997;78(8):755–8. [https://doi.org/10.1016/S0003-9993\(97\)90085-X](https://doi.org/10.1016/S0003-9993(97)90085-X)
 46. Corvol A, Dreier A, Prudhomme J, et al. Consequences of clinical case management for caregivers: a systematic review. *Int J Geriatr Psychiatry.* 2017;32(5):473–83.

47. Lee H, Waite LJ. Cognition in Context: The Role of Objective and Subjective Measures of Neighborhood and Household in Cognitive Functioning in Later Life. *Gerontologist*. 2018;58(1):159–69. <https://doi.org/10.1093/geront/gnx050>
48. Henshall C, Cipriani A, Ruvolo D, et al. Implementing a digital clinical decision support tool for side effects of antipsychotics: A focus group study. *Evid Based Ment Health*. 2019;22(2):56–60. <https://doi.org/10.1136/ebmental-2019-300086>
49. Luig T, Asselin J, Sharma AM, Campbell-Scherer DL. Understanding implementation of complex interventions in primary care teams. *J Am Board Fam Med*. 2018;31(3):431 - 44. <https://doi.org/10.3122/jabfm.2018.03.170273>

Intermezzo

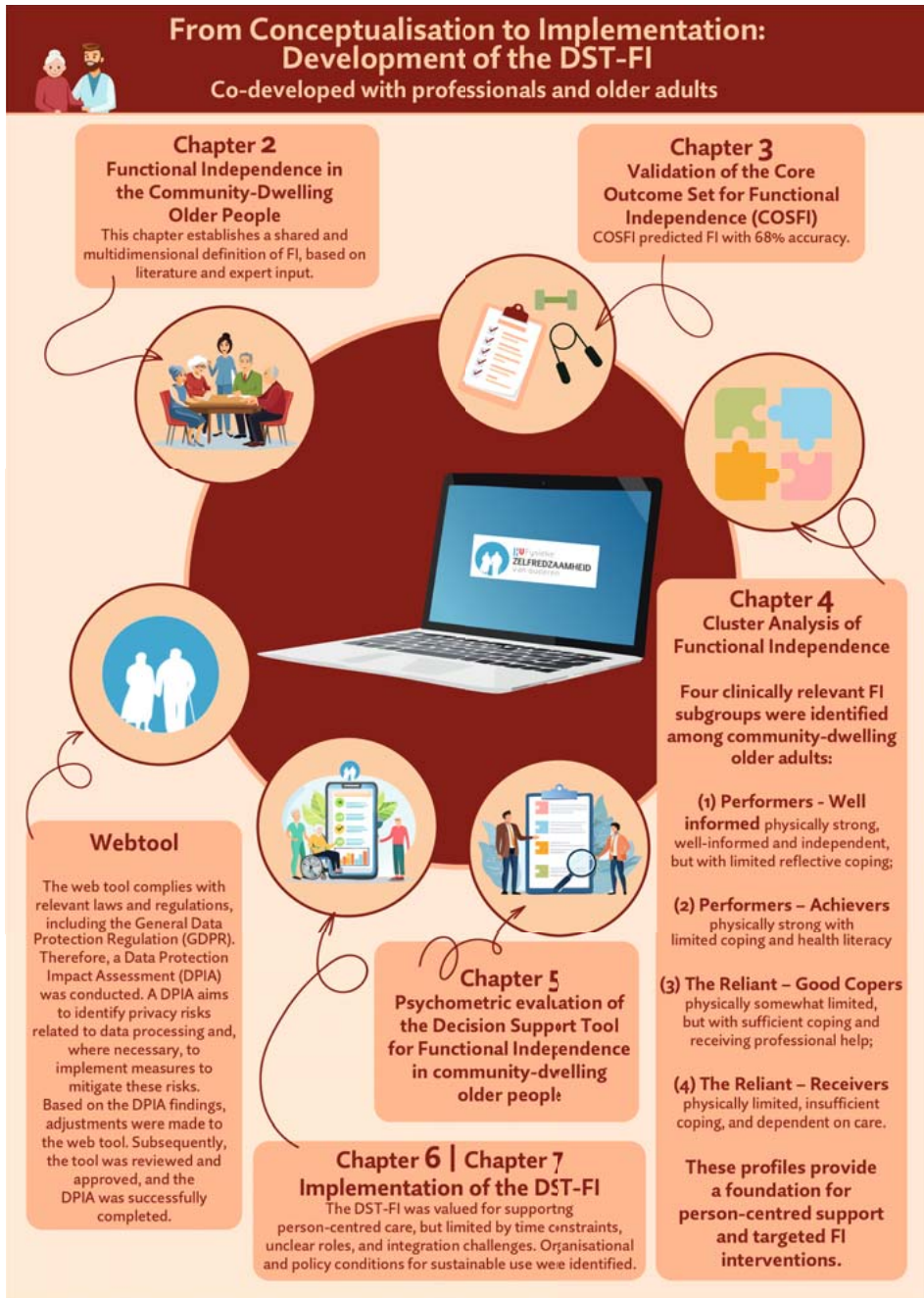
From conceptualisation to implementation:

Development and application of the DST-FI

This intermezzo marks the transition from the conceptual development of the DST-FI to its practical application and implementation.

Application of the DST-FI in Clinical Practice





Chapter 6

Exploring Feasibility and Acceptance of the Functional Independence Decision Tool Among Physical Therapists and Older Persons

Esther Molenaar, Di-Janne Barten, Nienke Bleijenberg,

Niek de Wit, Cindy Veenhof

Under review

ABSTRACT

Introduction: The aging population in the Netherlands is growing rapidly, with 4.7 million people aged 65 and older expected by 2040. Many face challenges in maintaining functional independence (FI), a key factor for aging in place. A prototype tool was developed to support physical therapists in promoting FI through integrated assessments and tailored advice. This study explores the feasibility of implementing the tool in clinical practice.

Methods: A mixed-methods feasibility study was conducted, examining demand, acceptance, and implementation. Quantitative data were collected from physical therapists and older adults using the AIM, IAM, MISII, and CSQ, and analyzed descriptively. Qualitative interview data from both groups were thematically analyzed.

Results: Fifteen physical therapists and 14 older adults participated. Both groups recognized the tool's value in assessing FI, though usability perceptions varied. Therapists reported concerns about time constraints, integration into workflows, and interpreting results. Older adults found the tool beneficial for awareness and decision-making and were willing to recommend it to others.

Discussion: The tool shows potential but requires refinement. Enhancing usability, minimizing administrative burden, and embedding the tool into practice may improve feasibility. Older adults responded positively, indicating a clear need for such support.

Conclusion: The tool appears feasible for assessing FI. Further development and research are needed to support its effective clinical implementation.

CONTRIBUTION OF THE PAPER

This study provides first-time insights into the feasibility of the Decision Support Tool for Functional Independence (DST-FI) in primary care physiotherapy, based on perspectives of both physiotherapists and older adults.

The results highlight both the perceived value and the practical barriers to implementing the DST-FI, such as time constraints, workflow integration, and the need for clearer guidance.

The study emphasizes the potential of the DST-FI to support generalist physiotherapists in delivering structured, person-centred care to older adults, and offers direction for further development and implementation strategies.

Keywords: Functional Independence · Older adults · Physiotherapy · Feasibility study · Primary care

INTRODUCTION

The number of persons aged 65 and above is expected to rise sharply, accompanied by an increase in the proportion of older persons experiencing physical functioning problems. In 2023, 20.2% of the Dutch population—approximately 3.6 million people—were aged 65 or older. This number is projected to grow to 4.8 million by 2040, representing about 25% of the total population (1). Currently, 96% of individuals aged 75 and older have at least one chronic disease, and 86% suffer from multimorbidity, meaning they have two or more chronic conditions (2). Furthermore, people aged 65 and older now represent over one-third of all patients seen in primary care.

Physical functioning is a key requirement for maintaining Functional Independence (FI). In line with the global focus on enabling people to age in place and to support those with limitations in physical functioning, the emphasis is increasingly placed on preserving FI. FI is defined as “the ability to function safely and independently in one’s own context” and is a complex, multidimensional construct encompassing physical capacity, coping mechanisms, empowerment, and health literacy (3). Currently, there is no standardized approach in primary care to assess and support FI in older adults. As a result, signs of declining independence may go unnoticed until more severe limitations arise, often leading to avoidable loss of autonomy or increased healthcare needs. The Decision Support Tool for Functional Independence (DST-FI) addresses this gap by providing structured, practical guidance for healthcare professionals. It integrates validated assessments with tailored recommendations, allowing for early identification of support needs and facilitating timely, person-centered interventions (4). By offering insights into the complex factors influencing FI, the DST-FI aims to provide informed decisions and support older adults in maintaining or improving their independence for as long as possible (4).

The DST-FI is a valid and reliable measurement tool to support physical therapists in monitoring FI and coaching or advising community-dwelling older persons aged 65 years and older to maintain their functional independence (4,5). However, implementing the DST-FI in clinical practice proves to be complex. Physical therapists, in particular, are well-suited to use this tool given their expertise in administering physical assessments essential for evaluating FI (6). With the growing population of older persons, the physiotherapy profession faces increasing demands, as older persons with challenges in physical functioning are expected to constitute the largest proportion of physical therapy patients across various practice settings (7). However, a shortage of physical therapists specializing in geriatrics poses significant challenges in meeting this demand (7). Consequently, many older persons are receiving care from non-specialized physical therapists (8). Physical therapists’ expertise uniquely positions them to administer the physical assessments necessary for accurately evaluating functional independence (9). However, gaining a complete understanding of the broader, multidimensional nature of FI can be challenging—particularly for generalist physical therapists. The DST-FI can support them by providing structure and insight into this complexity, helping to identify care needs more precisely and guiding appropriate interventions.

Previous research has highlighted the important role of facilitators and barriers in influencing the adoption and effectiveness of such tools (blinded for review). The most important facilitators focus on the potential for collaboration, well-informed decision-making, and addressing societal pressures. Conversely, four identified barriers encompass limited applicability, time constraints, ownership issues, and challenges in preventive outreach. Conducting a feasibility study and exploring the acceptance is a logical next step and provides valuable preparation for implementing the tool in clinical practice (10). This process gathers insights to adapt the tool to local clinical needs, identify necessary modifications, and ensure input from diverse perspectives, enabling context-specific customization and increasing implementation success (11).

The primary objective of this study is to explore the feasibility of the DST-FI in physical therapy practice, from the perspectives of both physical therapists and community-dwelling older persons. With the insights obtained, we intend to offer specific recommendations for the tool's practical use, enabling its effective utilization and preparation for implementation.

METHOD

Design

We designed a feasibility study guided by the Medical Research Council (MRC) framework and employing a basic Mixed-Methods Design with a convergent parallel design to validate findings and gain a deeper, context-rich understanding of the feasibility outcomes (12,13). This approach combines quantitative and qualitative methodologies, enabling a comprehensive evaluation of feasibility outcomes while capturing contextual insights to refine the intervention (14-16).

Study Participants

The study population consisted of physical therapists as the primary target group and community-dwelling older adults as the secondary group. Given the pragmatic nature of this feasibility study, a convenience sampling method was used for the inclusion of both physical therapists and older adults (17). Physical therapists were the main focus, as they are the intended users of the DST-FI in clinical practice. Older adults were included to assess their perspectives on the tool's relevance, usability, and impact on their functional independence.

Physical therapists

Physical therapists were the primary target group for this study. The inclusion criteria for participation was working with community-dwelling older persons aged 65 years and older. Physical therapists were recruited in two ways: a flyer with a call for action to participate in the study was distributed by email to physical therapists from the research group network and displayed on the research group's (social) media channels. Additionally, the flyer was distributed to students of the master's program in geriatric physical therapy at the University of applied sciences (blinded for review), and the call was included in the newsletter of the Dutch Association for Geriatric Physiotherapy (NVFG). The recruitment efforts aimed to include physical therapists from diverse work regions and

environments, from monodisciplinary primary care practices and multidisciplinary health centers in the Netherlands.

Older persons

The secondary target group consisted of community-dwelling older persons aged 65 and older who had completed a Functional Independence assessment using the DST-FI. They were invited to participate in the study to assess its feasibility from an end-user perspective. Recruitment was facilitated through the participating physical therapists, who informed patients about the study when they intended to use the DST-FI tool as part of their treatment. Older persons were then provided with leaflet materials containing the researcher's contact information. The study enrolled persons aged 65 years or older, residing at home, who had received advice from their physical therapist based on the DST-FI assessment and were able to understand verbal and written instructions in Dutch. Older persons with cognitive impairment preventing independent completion of the required questionnaires, as determined by the clinical judgment of the physical therapist, were excluded from the study. A purposive sample of at least 12 older adults was targeted for interviews. Research suggests that within such a sample, key themes and diverse perspectives can be identified early, providing a comprehensive understanding of participants' experiences and viewpoints (18,19). This sample size was expected to capture a broad range of insights regarding the usability and perceived value of the DST-FI.

Decision Tool Functional Independence

The DST-FI was developed as a digital tool (The tool is digitally accessible (link blinded for review) and consists of three sequential parts: (I) Measuring: A cross-disciplinary measurement set designed to assess the FI level of persons aged 65 years and older living in the community (Core Outcome Set Functional Independence (5); (II) Matching: Based on the outcomes of the measurement set, persons aged 65 years and older living in the community are classified into one of the four validated subgroups of Functional Independence: Well-Informed, Achievers, Good Copers, and Receivers (20); (III) Generating: Selecting appropriate (healthcare) professional(s) based on the most appropriate subgroup, to maintain or improve the level of FI for community-dwelling older persons aged 65 years and older (4).

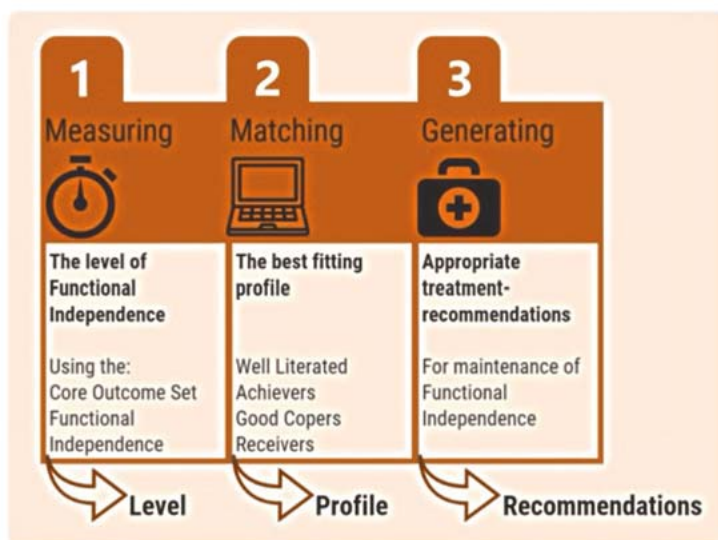


Figure 1. Graphical illustration of the operation of the DST-FI.

Study Outcomes

The primary outcome was the feasibility of the DST-FI. Following the framework of Bowen et al. (11), feasibility was conceptualized as a multidimensional construct and operationalized through three specific domains: *demand*, *acceptance*, and *implementation* (11). **Demand** refers to ‘the extent to which the DST-FI was likely to be utilized’. **Acceptance** pertains to ‘the perceived acceptability of the DST-FI, including its suitability, appropriateness, and whether it was viewed positively or negatively by the two stakeholder groups’. **Implementation** examines ‘the effectiveness of implementing the DST-FI, the resources required for sustained implementation, and the factors influencing its continuity’.

Data Collection

Physical therapists

For the construct **Demand**, quantitative data collection included the percentage of patients aged 65 and older for whom participating physical therapists used the DST-FI tool and a question from the Technology Acceptance Measurement (TAM), which evaluates users’ acceptance of technology. The specific question used in this context relates to ‘behavioral intention to use,’ which, although part of TAM, provides valuable insight into the demand for the tool. Specifically, behavioral intention was assessed with the statement: ‘*I presently intend to use the DST-FI tool regularly at work*’ (Likert scale 1-5)(21). This question reflects not only the acceptance of the tool but also the users’ intention and willingness to use it in the future, serving as an indirect measure of demand.

For **Acceptance**, quantitative data were gathered using validated instruments, including the Acceptability of Intervention Measure (AIM)(22), which evaluates the perceived acceptability of an intervention, the Measure of Innovation-Specific Implementation Intentions (MISII)(23), which assesses the strength of implementation intentions for a specific innovation, and the Intervention Appropriateness Measure (IAM)(22), which examines the perceived fit of an intervention within a given context. All instruments employed Likert scale responses.

For **Implementation**, open-ended questions captured detailed insights into various factors such as the degree of implementation, resource requirements, and participants' ability to engage with the intervention.

To complement the quantitative findings, open-ended questions were included in the surveys among physical therapists. These questions allowed participants to elaborate on their responses, providing additional context and a more nuanced understanding of the feasibility outcomes. For a detailed specification of the feasibility objectives and related data collection methods for the DST-FI, please refer to Table 1.

Table 1. Feasibility Goals for Data Collection on the Decision Tool Functional Independence (DST-FI) by Physical Therapists, Structured According to Bowen et al. (11).

Construct of feasibility	Operationalization	Quantitative data	Qualitative data
Demand	The actual usage of the DST-FI by participating Physical therapists in the population of community-dwelling persons aged 65 and older.	Question: Percentage of patients over the age of 65 for whom participating Physical therapists used the tool.	Additional open-ended question.
	The intention to use the DST-FI tool in practice by Physical therapists for community-dwelling persons aged 65 and older.	Question from the Technology Acceptance Measurement (TAM) about the Behavioral Intention to use (BI) (21). "I presently intend to use the DST-FI tool regularly at work." Question Likert scale 1-5	Additional open-ended question
Acceptance	General Acceptance	Acceptability of Intervention Measure (AIM)(22) Questionnaire (4 items, Likert scale 1-5)	Additional open-ended question
	Intention to continue use	Measure of Innovation-Specific Implementation Intentions (MISII) (23). Questionnaire (9 items, Likert Scale 1-5)	Additional open-ended question
	Perceived appropriateness	Intervention Appropriateness Measure (IAM) Questionnaire (4 items, Likert Scale 1-5)	Additional open-ended question
	Connection to organizational culture		Open question: based on the CFIR interview guide tool (24)
Implementation	• Degree of implementation • Success or failure of implementation • Amount and type of resources needed for implementation • Factors affecting ease or difficulty of implementation • Efficiency, speed, or quality of implementation • Positive/negative effects on intended participants, Participants' ability to carry out intervention activities		Open-ended questions

Older persons

The data collection among older persons consisted of both quantitative and qualitative data. The qualitative interview data collected from participants aged 65 and older informed the feasibility outcomes; demand, acceptance, and implementation, as well as considerations for implementation. To assess the overall acceptance, demand, and implementation of the DST-FI among persons aged 65 years and older, the Dutch translation of the Client Satisfaction Questionnaire was used (CSQ) (25). In addition, we conducted structured interviews, guided by an interview guide, to evaluate the demand, acceptance, and implementation of the tool among persons of 65 years and older. The interview guide is based on topics described by Bowen et al. (11) (Appendix A). For a more detailed specification of the feasibility objectives related to data collection among people over 65 regarding the DST-FI, please refer to Table 2.

Table 2. Feasibility Goals for Data Collection Among Adults Aged 65 and Older on the Decision Tool Functional Independence (DST-FI), Structured According to Bowen et al (11).

Construct of feasibility	Operationalization	Instrument	
		Quantitative data	Qualitative data
Acceptance/ demand	The acceptance of the use of the DST-FI and accompanying advice by the physical therapist and Satisfaction with the use of the DST-FI.	The Client Satisfaction Questionnaire (CSQ) (15) Questionnaire, (8 items, Likert Scale 1-5)	Interview
Implementation	Opinion on received advice from the DST-FI.		Interview

Quantitative data analysis

Descriptive statistics were applied to characterize the demographic features of the study population. Analyses were conducted on participants’ gender (M/F/X), years of work experience (0-5, 5-10, 10-20, >20), specialization in geriatrics (yes/no), and work setting (private practice/health center/nursing home/hospital/health organization). Demographic data were summarized using means and standard deviations or medians and interquartile ranges for continuous variables, and proportions for categorical variables.

Furthermore, outcomes on the feasibility questionnaires (AIM, MISII, IAM, CSQ) were presented with medians with interquartile ranges. Statistical analyses were performed using IBM Statistical Package for the Social Sciences (SPSS, version 24,0 Armonk, New York, USA).

Qualitative data analysis

The interviews with older persons were audio-recorded and subsequently transcribed verbatim. After pseudonymization, where each participant was assigned a unique pseudonym, personal information was de-identified, preserving data integrity for analysis and reporting purposes. The pseudonyms, known only to the research team, were securely stored separately from the collected

data to ensure anonymity. Inductive thematic analysis (TA) was applied to both the open-ended survey responses and interview data to identify emergent themes and subthemes (26,27). TA facilitated the organization, analysis, and conceptualization of patterns or themes within the dataset (28). The qualitative data from interviews among older persons and open-ended questions of the surveys among physical therapists were analyzed through the six stages of TA to inductively organize, interrogate, and interpret the data.

To ensure consistency among reviewers, a second reviewer independently coded 10% of the transcripts. A consensus approach was used to build agreement on emerging themes, with any disagreements resolved through discussion and review of the data and coding. Discussions with members of the research team on the developing analysis further enhanced the rigor of the qualitative process. When participants agreed to this, a member check was conducted, and relevant information suggested by the participants was incorporated into the analysis to enhance its comprehensiveness. Coding was conducted using Atlas. ti software (version 23.3.4).

Ethical considerations

Before participation, all persons received detailed information about the study through a participant information letter at least one week in advance. They were then screened for eligibility by the researcher. After confirming their understanding of the study details and addressing any questions, participants provided written informed consent by signing a consent form. This procedure applies to both physical therapists and persons aged 65 years and older. The study protocol was approved by the the Research Ethics Committee (blinded for review)(reference number 277-000-2024).

RESULTS

Study population

Physical therapists

Twenty physical therapists were approached, of whom 15 completed all questionnaires. Participant characteristics are presented in Table 1. Most were female and specialized in geriatric physical therapy, with varied years of professional experience. They worked in diverse settings, including private practices, nursing-/care homes, and healthcare organizations.

Table 3. Demographic information: Descriptive statistics were used to describe the demographic characteristics of the included physical therapists.

Demographic information	N
No. of respondents	15
Years of Work experience (N(%))	
0-5	5 (33%)
5-10	4 (27%)
10-20	4 (27%)
>20	2 (13%)
Gender, female (N (%))	13 (87%)
Specialized in Geriatrics (N (%))	12 (80%)
Work setting (N (%))	
Private practice	6 (40%)
Nursing home/Care home	8 (53%)
Hospital	0 (0%)
Health care organization	1 (7%)

Older persons

Fourteen participants were approached, all of whom completed the questionnaires. Between February 2024 and August 2024, semi-structured interviews were conducted with participants aged 65 years and older. The interviews lasted an average of 33 minutes, ranging from 13 to 48 minutes. A maximum duration of 45 minutes was established to minimize participant burden. The characteristics of the older persons are shown in Table 2, which also outlines the profiles of the older persons as determined by the DST-FI tool. These profiles—Well-Informed/ Achievers, Good Copers, and Receivers—are derived from cluster analyses established in a previous study (blinded for review). This framework categorizes community-dwelling older persons into four distinct and clinically relevant subgroups based on their level of functional independence (FI). Each subgroup highlights differences in functional independence by identifying which domain (e.g., physical strength, coping ability, or resource use) is most affected.

Table 4. Demographic Characteristics of Participants Aged 65 and Older

Participant pseudonym	Age (y)	Gender (M/F)	Education level*	Level of FI **
Older Person 1	81	M	High	Achiever
Older Person 2	73	M	Middle	Achiever
Older Person 3	79	M	High	Good Coper/Receiver
Older Person 4	87	F	Middle	Good Coper
Older Person 5	77	F	Middle	Good Coper/Receiver
Older Person 6	78	F	High	Good Coper/Receiver
Older Person 7	84	F	Middle	Receiver
Older Person 8	85	F	Middle	Receiver
Older Person 9	65	F	Middle	Well Informed
Older Person 10	65	M	Middle	Well Informed
Older Person 11	65	F	High	Well Informed
Older Person 12	86	M	High	Receiver
Older Person 13	80	F	Middle	Good Coper
Older Person 14	77	F	Middle	Good Coper/Receiver

*Educational level according to the Dutch Central Bureau of Statistics; High (associate degree programs, higher education bachelor programs; Master degree programs, Avarage (upper secondary education, (basic) vocational training and middle management and specialist education) and Low (primary and special primary education).

** Persons classified as "Well informed" or "Achiever" do not fall or require assistance and are therefore considered functional independent. Those marked as "Good copers" or "Receivers" are categorized, based on previous research, into clusters that are less or not functional independent based on earlier cluster analyses (blinded for review).

Demand

Physical therapists

All participating physical therapists used the DST-FI tool in 10% or less of their patients aged 65 and older, with a range from 0 to 10%. The tool was primarily used to assess the measurement instrument for this study and to explore its functionality and added value for physical therapy care.

Physical therapists expressed overall mixed views on the intended use of the DST-FI, highlighting reasons for both continued use and discontinuation. Firstly, **reasons for continued use** include the valuable insights the tool provides into the physical and cognitive outcomes of vulnerable, older persons particularly in cases where the origins of limitations in FI are uncertain. Additionally, its user-friendliness and quick access to actionable data enhance the willingness for repeated application.

Secondly, **reasons for the potential discontinuation** of the DST-FI in the future include the time required to use the tool, which some physical therapists find burdensome. For example, in busy clinical settings, therapists may feel that the tool takes too much time away from direct patient care. Additionally, for patients who have been in treatment for an extended period, the tool may be perceived as unnecessary, especially when they are already receiving ongoing care. Some therapists report that the tool offers limited value, particularly in cases where patients are receiving care from

multiple providers, which can make the addition of another tool seem redundant. Further challenges include language barriers, especially in diverse patient populations, and cognitive or digital limitations that hinder the tool’s accessibility for certain groups. A significant barrier to consistent use is the lack of clear guidance on interpreting the scores and norms of the various measurement instruments included in the DST-FI. This uncertainty can lead to confusion among both therapists and patients, causing hesitation in using the tool and ultimately contributing to reluctance in its adoption.

Table 5 presents the outcomes of the feasibility questions related to the construct of Demand. The table includes results from one developed question addressing **perceived demand** and one question derived from the Technology Acceptance Model-**Behavioral Intention** (TAM-BI) scale. These results are presented as medians with interquartile ranges (IQR) to provide a robust summary of the data distribution and variability.

Table 5. Outcomes of Feasibility Questions on the Construct of Demand, Assessed Among Physical Therapists. These Findings Provide Insights into the Perceived Demand for and Intent to Use the DST-FI Tool in Clinical Practice.

Demand	
N	14
Percentage of patients over the age of 65 for whom participating Physical therapists used the tool.	
(M (SD))	4.1 (3.73)
TAM- BI: (M (Range))	
“I presently intend to use the DST-FI tool regularly at work.”	3 (1-5) *

*Question Likert scale 1-5: extremely agree- extremely disagree

Persons 65 years and older

Concerning demand, the findings from the Client Satisfaction Questionnaire (CSQ), shown in Table 6, reveal that the majority of older persons felt the DST-FI tool met their needs and provided valuable help in managing their health issues. Most participants were satisfied with the quality of the tool, the help they received, and the extent to which the tool addressed their concerns. A significant number of older persons indicated they would recommend the DST-FI to others, highlighting its perceived utility. Additionally, a high level of satisfaction was reflected in the overall scores, with respondents expressing a strong likelihood of using the tool again if needed.

In line with these quantitative findings, qualitative interviews also highlighted the added value of the tool. Older persons expressed satisfaction with their physical therapist’s use of the DST-FI tool, with many stating that the tool has been helpful and would recommend the decision tool to others. Similar to the physical therapists, older persons in the interviews highlighted the added value of the tool:

OP 9: “It’s really about assessing how fit you still are. I find that important. So if I have any issues, I can seek help.”

OP 13: “I definitely find it valuable. It can help you better address future things and say: I still need to work on this and that.”

Table 6. Client Satisfaction Questionnaire (CSQ) Outcomes on Demand and Acceptance Among Persons Aged 65 and Older

Demand/acceptance	
N	12
Question: scale 1-5	(M (Range))
Item 1: “What do you think of the quality of the Functional Independence Decision Tool?”	4 (1-4)
Item 2: “Did you receive the type of help you were hoping for?”	3 (2-4)
Item 3: “To what extent has the decision tool met your needs?”	2 (1-4)
Item 4: “If one of your friends or acquaintances needed the same kind of help, would you recommend the Functional Independence Decision Tool?”	3 (1-4)
Item 5: “How satisfied are you with the amount of help you received?”	2 (1-4)
Item 6: “Has the Functional Independence Decision Tool (DST-FI) helped you better manage your issues?”	2 (2-2)
Item 7: “Overall, how satisfied are you with the Functional Independence Decision Tool (DST-FI)?”	4 (1-5)
Item 8: “Would you retake the tests associated with the Functional Independence Decision Aid (DST-FI) if needed?”	4 (1-5)

Integrated Results on Demand for the DST-FI Tool

Both physical therapists and persons aged 65 and older recognize the DST-FI’s potential to improve **understanding** of FI, which could positively influence future use of the application by physical therapists. However, physical therapists also report practical challenges, such as the time commitment required, which may negatively influence their intention to use the DST-FI tool in practice.

Acceptance

Physical therapists

As seen in Table 7, physical therapists expressed moderate approval of the tool’s suitability and usefulness, but the perceived attractiveness and enjoyment of the tool scored lower. There is some uncertainty among physical therapists about using the tool with older persons in the future. However, they indicate that they would primarily use the tool to meet patient needs and when it is appropriate for the specific patient. Overall, using the tool is not a priority, and physical therapists generally do not intend to use it regularly because it cannot be applied to every client or may not be suitable for all cases. However, they do express interest in using certain components of the tool.

PT: “I plan to use parts of the DST-FI like handgrip strength, SPPB, assistance, and falls. I’ll skip the coping questionnaire, as I find it too time-consuming and potentially unreliable for older patients. I might use the health literacy questionnaire selectively but would prefer more focus on physical activity rather than just nutrition, literacy, and numeracy.”

Persons aged 65 and older

As shown in Table 6, a significant portion of persons aged 65 and older reported that the tool meets their needs, that the decision tool was helpful, and that they would recommend others in their age group. However, they rated different components of the DST-FI tool variably. In addition to the outcomes on the CSQ, during the interviews, some respondents indicated having difficulty understanding the purpose of the Coping Flexibility Questionnaire (CO-FLEX) and The Newest Vital Sign-D (NVS-D), finding them challenging to complete:

OP8: “It [NSV-D] just doesn’t interest me, so it doesn’t sink in.”

OP6: “It [CO-FLEX] felt repetitive, like a chant, and you had to be careful not to respond automatically.”

Integrated Results on Acceptance for the DST-FI Tool

Both physical therapists and persons aged 65 and older indicated that they accept the tool as appropriate and suitable. However, they rated its different components variably. Both groups expressed reservations about fully embracing the questionnaires. The results from the AIM, MISII, and IAM questionnaires highlight that while physical therapists approve of the DST-FI tool and acknowledge its relevance, they are less enthusiastic about using all its components, particularly the questionnaires themselves.

Table 7. Scores from the AIM, MISII, and IAM Questionnaires on the Acceptance of the DST-FI Tool Among Physical Therapists

Acceptance	
N	15
AIM (General Acceptance)	(M (Range))
Item 1: “: ‘The DST-FI has my approval.”	4 (1-5)
Item 2: “: ‘The use of the DST-FI is attractive to me.”	3 (1-5)
Item 3: “I find the DST-FI tool enjoyable.”	4 (2-5)
Item 4: “: ‘I approve of the DST-FI tool’.	4 (1-5)
MISII (intentions to use)	(M (Range))
Item 1: “I consider using the DST-FI tool with new patients.”	4 (1-5)
Item 2: “I plan to use the DST-FI with my patients.”	4 (1-5)
Item 3: ““I will apply the DST-FI to meet the needs of my patients.”	4 (1-5)
Item 4: ““I am planning to use the DST-FI when it is appropriate for my patients.”	4 (1-5)
Item 5: ““The use of the DST-FI is a high priority for me.”	3 (1-5)
Item 6: ““I strive to apply the principles of the DST-FI when working with my patients.”	4 (1-5)
Item 7: ““I will use all aspects of the DST-FI with my patients.”	4 (1-5)
Item 8: “I will use parts of the DST-FI with my patients.”	4 (3-5)
Item 9: “I will use certain strategies from the DST-FI with my patients.”	4 (3-5)
IAM (Intervention Appropriateness Measure)	(M (Range))
Item 1: “The DST-FI seems appropriate.”	4 (2-5)
Item 2: “The DST-FI seems suitable.”	4 (2-5)
Item 3: “The DST-FI seems applicable.”	4 (2-5)
Item 4: “The DST-FI seems to fit well.”	4 (2-5)

*Question Likert scale 1-5: extremely agree- extremely disagree

Implementation

Physical therapists

Based on the open-ended questions, the tool was generally perceived as both feasible and user-friendly, which supports its practical implementation. Physical therapists appreciated the tool’s clear structure and valued the fact that the assessment set can be completed within a single treatment session. This efficiency was seen as a key strength. At the same time, time constraints in daily practice remain a broader barrier to adoption, as integrating a new tool—even if concise—still requires adjustment and prioritization.

Additionally, many older persons may face limitations in digital access or lack the technical skills needed to effectively engage with digital tools, which presents a practical challenge. This digital component may also place an additional burden on healthcare providers, potentially hindering wider implementation of the DST-FI, in the current version of the tool.

PT: “The tests are easy to perform. However, the absence of an email address for patients makes digital entry impossible.”

Furthermore, healthcare providers noted that some questionnaires within the tool, can be overly complex or confusing for certain patients. This may lead to incomplete responses. Physical therapists suggest that additional support or adjustments to these questionnaires may be beneficial to make the tool easier to use and to facilitate its implementation. Furthermore, they also suggest providing additional instructions for this component could assist patients in completing it more confidently.

PT: “The tool can be implemented within the treatment time. However, the patient felt uncertain about the coping questionnaire and the health literacy questionnaire. The patient was unsure how to answer the coping questions and couldn’t provide any answers for the health literacy questions”.

Persons aged 65 and older

Implementation of the advice provided by the tool was mixed, according to interviews with participants aged older than 65. While respondents generally found the advice understandable, they reported several barriers to following it, including unclear guidance on how to practically implement the recommendations, lack of motivation, perceived irrelevance, and a lack of clear necessity for adhering to the advice. Respondents emphasized the key role of physical therapists in supporting adherence to the advice.

For example, some participants felt that the recommendations were too vague or generic to be actionable.

OP11: “The recommendations in the leaflet, like ‘get in touch with,’ are quite vague. It might help if it was clearly explained how and through whom to do that.”

Others highlighted that the advice needed to be personally relevant and well-explained to feel motivating:

OP6: “Well, this is, of course, stated very generally. I don’t think that increases motivation. So there needs to be a clear message tied to it. You have to explain why it’s useful. And you also need to find it useful yourself. If I do, I’m very motivated.”

OP3: “No, that’s not for me at all, occupational therapy. No. Maybe in a year or so, I don’t know, but definitely not right now.”

Integrated Results on Implementation for the DST-FI Tool

The tool is generally suitable for daily use, as it offers a clear structure and aligns well with treatment timelines, making it accessible for physical therapists to implement. However, persons aged 65 and older reported barriers to following the advice, such as unclear instructions for contacting recommended healthcare providers, limited motivation, perceived irrelevance, and a lack of necessity. They emphasized that physical therapists play a crucial role in helping them engage with

the guidance, underscoring the need for additional support from healthcare providers. Practical adjustments—like removing the email requirement and simplifying certain components—could improve the tool’s integration into practice and make it more user-friendly for older patients.

DISCUSSION

This study assessed the feasibility, acceptance, and implementation of the DST-FI tool among physical therapists and older adults aged 65 and above. The majority of physical therapists reported using the tool in less than 10% of their patients, with its application primarily limited to the context of this study to evaluate its functionality. While therapists recognized the tool’s value, particularly for assessing vulnerable individuals, challenges such as time constraints, complexity of certain components, and unclear guidance for interpretation were highlighted. Older adults generally found the tool helpful, with most expressing satisfaction and willingness to recommend it, although some faced difficulties with specific questionnaires. The implementation of the tool’s recommendations was mixed, with physical therapists playing a crucial role in supporting adherence and motivation.

Demand

Our findings indicate that there is mixed enthusiasm for the DST-FI tool. While physical therapists acknowledged its potential to assess FI in older persons, the demand for its adoption varied significantly. The primary concern was the time investment required to utilize the tool in a busy clinical setting properly. Although therapists recognized the potential benefits of the tool, including its ability to provide additional insights into older persons’ FI, the administrative burden posed a significant challenge to regular use. This variation in demand aligns with prior research, which suggests that the willingness of stakeholders to adopt innovations is often influenced by factors such as time and effort required for implementation. Creating an innovation-friendly climate, including providing funding or compensating the time required for the tool’s use, could positively affect demand by easing the perceived barriers and improving its overall feasibility (30). In contrast, older persons demonstrated a higher level of demand, as most persons reported finding the DST-FI tool helpful in understanding their capabilities and guiding their care planning. The tool’s utility for empowering persons and enhancing patient engagement was a recurring theme, positive for using the tool among this group (31).

Acceptance

The acceptance of the DST-FI tool varied across stakeholders, particularly among physical therapists. Some recognized its potential to enhance patient-centered care and provided a detailed assessment of functional independence. However, others expressed reservations because of the tool’s complexity and the challenges of interpreting the results. A common concern was the need for additional training to ensure effective use of the tool, which was frequently cited as a critical factor in increasing acceptance. This reflects previous research indicating that an innovation-friendly environment, including enhanced training and development opportunities, can help address these

concerns and support wider adoption. Addressing the demand for such support can be crucial in fostering positive attitudes toward innovation and improving its feasibility (32).

Older persons, on the other hand, were generally positive about the DST-FI tool. Feedback indicated that participants considered it straightforward and valuable, and they were willing to recommend it to others. These findings are in line with previous research on decision aids, which shows that they can enhance understanding, reduce passivity in decision-making, and lower decisional conflict stemming from feeling uninformed (33). This positive reception may significantly influence the acceptance of the DST-FI tool, as it meets older adults' need for clearer and more informed decision-making (34).

Implementation

The practical implementation of the DST-FI tool presented challenges such as significant time and resource demands for physical therapists to integrate it into clinical workflows. Organizational support, training, and concerns over the tool's applicability to all patients were identified as key factors for successful implementation. These challenges align with common barriers reported in related studies, such as time constraints, lack of applicability due to patient characteristics, and clinical circumstances (35). These findings underline the importance of considering not only the tool itself, but also the broader context of its use — a point explored further in the following methodological reflection.

Methodological considerations

Reflecting on the study design, it is important to note that this was a mixed-methods pilot study. This approach allowed for a comprehensive exploration of both quantitative and qualitative aspects of feasibility. However, due to the small sample size inherent in pilot studies, the findings are preliminary and primarily intended to inform further refinements of the DST-FI and guide future research (11). Despite the limited sample size, the study provided valuable insights into the DST-FI tool's potential, aligning with its focus on feasibility rather than generalizability. A significant number of physical therapists declined participation, primarily citing time constraints rather than substantial bias against the DST-FI tool itself. However, this may still have influenced the study's results by skewing the sample toward therapists more open to innovation or with manageable workloads. Furthermore, older persons were recruited through their physical therapists, which may have influenced their decision to participate. Additionally, as the DST-FI was administered by their own physical therapists, there is a potential for social desirability bias, which could have led participants to provide more favorable feedback on the tool (36). These factors could have positively influenced the study's findings and should be considered when interpreting the results (37).

Implications for Practice

For successful use in daily practice, several lessons can be learned from our results. First, the DST-FI tool should be better integrated in the existing workflow and treatment approaches for older

clients (38). Additionally, physical therapists should be supported in interpretation of the results of the tool (39,40). Given the positive response from older persons, there might be potential for the DST-FI tool to contribute to patient-centered care when implemented with the appropriate support and modifications.

Implications for Future Research

In addition to refining the DST-FI tool for integration into clinical practice, future research should focus on assessing its (cost) effectiveness compared to current methods used to assess Functional Independence (FI) in older adults. This would involve evaluating whether the DST-FI tool leads to better outcomes in monitoring and managing functional independence. Research could explore whether the tool facilitates more timely interventions, improves decision-making, and enhances the management of FI. Furthermore, additional studies should investigate how effectively older adults are able to follow the advice provided by the DST-FI tool and the impact this has on their functional independence.

Conclusion

The DST-FI tool shows potential as a feasible means of assessing Functional Independence in older persons. While physical therapists have reservations related to time and complexity, older persons have generally expressed positive responses, indicating a demand for its use. Enhancements to further optimize the tool, reduce the administrative burden, and provide comprehensive training could improve both its acceptance and implementation, fostering wider adoption in clinical practice. After adjustments, the tool should be further investigated for its effectiveness.

REFERENCES

1. Loket GL. Gezond en vitaal ouder worden – Feiten en cijfers ouderen. 2023; Available at: <https://www.loketgezondleven.nl/gezondheidsthema/gezond-en-vitaal-ouder-worden/feiten-en-cijfers-ouderen>.
2. VZinfo (RIVM). Chronische aandoeningen en multimorbiditeit naar leeftijd en geslacht. 2023; Available at: <https://www.vzinfo.nl/chronische-aandoeningen-en-multimorbiditeit/leeftijd-en-geslacht>.
3. Molenaar EALM, Barten JA, te Velde S, van der Schoot L, Bleijenberg N, de Wit NJ, et al. Functional Independence in the Community Dwelling Older People: a Scoping Review. *Journal of Population Ageing* 2020.
4. van Bijsterveld SC, Barten JA, Molenaar EALM, Bleijenberg N, de Wit NJ, Veenhof C. Psychometric evaluation of the Decision Support Tool for Functional Independence in community-dwelling older people. *J Popul Ageing* 2022 Mar 29:1–23.
5. Dockx YJC, Molenaar EALM, Barten DJA, Veenhof C. Discriminative validity of the Core outcome set functional independence in a population of older adults. *BMC Geriatr* 2020 Aug 26;20(1):309–6.
6. Molenaar EALM, Barten DJA, Bleijenberg N, de Wit NJ, Veenhof C. Exploring Barriers and Facilitators for the Potential Implementation of the Decision Tool-Functional Independence in Primary Care. Under Review 2024.
7. Wong R, Odum CJ, Barr JO. Building the Physical Therapy Workforce for an Aging America. *Journal of Physical Therapy Education* 2014;28(2).
8. Essential Competencies in the Care of Older Adults. *Journal of Physical Therapy Education* 2014;28(2).
9. Molenaar E, Barten JA, Bleijenberg N, de Wit NJ, Veenhof C. Exploring Barriers and Facilitators for the Potential Implementation of the Decision Tool-Functional Independence in Primary Care (submitted). 2025.
10. Pearson N, Naylor PJ, Ashe MC, Fernandez M, Yoong SL, Wolfenden L. Guidance for conducting feasibility and pilot studies for implementation trials. *Pilot and Feasibility Studies* 2020;6:1–12.
11. Bowen DJ, Kreuter M, Spring B, Cofta-Woerpel L, Linnan L, Weiner D, et al. How we design feasibility studies. *Am J Prev Med* 2009 May;36(5):452–457.
12. Medical RC. Developing and evaluating complex interventions: The new Medical Research Council guidance. London: Medical Research Council; 2006.
13. NIH Office of Behavioral and, Social Sciences. Best practices for mixed methods research in the health sciences. Bethesda: National Institutes of Health; 2018.
14. Shahsavari H, Matourpour P, Ghiyasvandian S, Nejad MRG. Medical Research Council framework for development and evaluation of complex interventions: A comprehensive guidance. *J Educ Health Promot* 2020 Apr 28;9:88.
15. Dawadi S, Shrestha S, Giri RA. Mixed-Methods Research: A Discussion on its Types, Challenges, and Criticisms. *JPSE* 2021;2(2):25–36.
16. Leech NL, Onwuegbuzie AJ. A typology of mixed methods research designs. *Quality & Quantity* 2009;43(2):265–275.
17. Francis JJ, Johnston M FAU - Robertson C, Robertson C FAU - Glidewell L, Glidewell L FAU - Entwistle V, Entwistle V FAU - Eccles M,P., M EMF-G, Jeremy, et al. What is an adequate sample size? Operationalising data saturation for theory-based interview studies. *Psychology & health JID* - 8807983 .
18. Moser A, Korstjens I. Series: Practical guidance to qualitative research. Part 3: Sampling, data collection and analysis. *Eur J Gen Pract* 2018 Dec;24(1):9–18.
19. Guest G, Bunce A, Johnson L. How Many Interviews Are Enough?: An Experiment with Data Saturation and Variability. *Field Methods* 2006;18(1):59–82.
20. Molenaar EALM, Barten DJ, de Hoop AMS, Bleijenberg N, de Wit NJ, Veenhof C. Cluster analysis of functional independence in community-dwelling older people. *BMC Geriatr* 2022 Dec 23;22(1):996–2.
21. Tao D. Understanding intention to use electronic information resources: A theoretical extension of the technology acceptance model (TAM). *AMIA Annu Symp Proc* 2008 Nov 6;2008:717–721.
22. Weiner BJ, Lewis CC, Stanick C, Powell BJ, Dorsey CN, Clary AS, et al. Psychometric assessment of three newly developed implementation outcome measures. *Implementation Science* 2017;12(1):108.
23. Moullin JC, Ehrhart MG, Aarons GA. Development and testing of the Measure of Innovation-Specific Implementation Intentions (MISII) using Rasch measurement theory. *Implementation Science* 2018;13(1):89.
24. Breimaier HE, Heckemann B, Halfens RJG, Lohrmann C. The Consolidated Framework for Implementation Research (CFIR): a useful theoretical framework for guiding and evaluating a guideline implementation process in a hospital-based nursing practice. *BMC Nursing* 2015;14(1):43.

25. de Brey H. A cross-national validation of the client satisfaction questionnaire: the Dutch experience. *Eval Program Plann* 1983;6(3-4):395–400.
26. Moser A, Korstjens I. Series: Practical guidance to qualitative research. Part 3: Sampling, data collection and analysis. *European journal of general practice* 2018;24(1):9–18.
27. Breimaier HE, Heckemann B, Halfens RJ, Lohrmann C. The Consolidated Framework for Implementation Research (CFIR): a useful theoretical framework for guiding and evaluating a guideline implementation process in a hospital-based nursing practice. *BMC nursing* 2015;14:1–9.
28. Braun V, Clarke V. Using thematic analysis in psychology. *Qualitative research in psychology* 2006;3(2):77–101.
29. Molenaar EALM, Barten DJ, de Hoop AMS, Bleijenberg N, de Wit NJ, Veenhof C. Cluster analysis of functional independence in community-dwelling older people. *BMC Geriatr* 2022 Dec 23;22(1):996–2.
30. Kelly CJ, Young AJ. Promoting innovation in healthcare. *Future Healthcare Journal* 2017;4(2):121–125.
31. Chaudoir SR, Dugan AG, Barr CHI. Measuring factors affecting implementation of health innovations: a systematic review of structural, organizational, provider, patient, and innovation level measures. *Implementation Science* 2013;8(1):22.
32. Al-Saleem AI, Aldakheel MK. Barriers to Workforce-Driven Innovation in Healthcare. *Cureus* 2024 Oct 24;16(10):e72316.
33. O'Connor AM, Stacey D, Rovner D, Holmes-Rovner M, Tetroe J, Llewellyn-Thomas H, et al. Decision aids for people facing health treatment or screening decisions. *Cochrane Database Syst Rev* 2001;(3):CD001431. doi(3):CD001431.
34. Charles C, Gafni A, Whelan T. Decision-making in the physician-patient encounter: revisiting the shared treatment decision-making model. *Soc Sci Med* 1999 Sep;49(5):651–661.
35. Légaré F, Ratté S, Gravel K, Graham ID. Barriers and facilitators to implementing shared decision-making in clinical practice: update of a systematic review of health professionals' perceptions. *Patient Educ Couns* 2008 Dec;73(3):526–535.
36. Grimm P. Social Desirability Bias. *Wiley International Encyclopedia of Marketing*; 2010.
37. Pallant J. *SPSS Survival Manual: A Step by Step Guide to Data Analysis using IBM SPSS*. : McGraw-Hill Education; 2013.
38. Kinney AR, Stearns-Yoder KA, Hoffberg AS, Middleton A, Weaver JA, Roseen EJ, et al. Barriers and Facilitators to the Adoption of Evidence-Based Interventions for Adults Within Occupational and Physical Therapy Practice Settings: A Systematic Review. *Arch Phys Med Rehabil* 2023 Jul;104(7):1132–1151.
39. Puccinelli-Ortega N, Cromo M, Foley KL, Dignan MB, Dharod A, Snively AC, et al. Facilitators and Barriers to Implementing a Digital Informed Decision Making Tool in Primary Care: A Qualitative Study. *Appl Clin Inform* 2022 Jan;13(1):1–9.
40. Grol R, Wensing M. What drives change? Barriers to and incentives for achieving evidence-based practice. *Med J Aust* 2004 Mar 15;180(S6):57.

APPENDIX A

INTERVIEW GUIDE BASED ON BOWEN ET AL.

This interview guide was developed using the feasibility framework described by Bowen et al.¹ The selected focus areas, **Acceptability**, **Demand** and **Implementation**, were considered most appropriate given the current phase of the implementation process and the outcomes of interest.

The table below presents the key focus areas for feasibility studies and their potential outcomes, as outlined by Bowen et al.¹

Area of focus	The feasibility study asks ...	Sample outcomes of interest
Acceptability	To what extent is a new idea, program, process or measure judged as suitable, satisfying, or attractive to program deliverers? To program recipients?	• Satisfaction • Intent to continue use • Perceived appropriateness • Fit within organizational culture
Demand	To what extent is a new idea, program, process, or measure likely to be used (i.e., how much demand is likely to exist?)	• Perceived positive or negative effects on organization • Actual use • Expressed interest or intention to use • Perceived demand
Implementation	To what extent can a new idea, program, process, or measure be successfully delivered to intended participants in some defined, but not fully controlled, context?	• Degree of execution • Success or failure of execution • Amount, type of resources needed to implement
Practicality	To what extent can an idea, program, process, or measure be carried out with intended participants using existing means, resources, and circumstances and without outside intervention?	• Factors affecting implementation ease or difficulty • Efficiency, speed, or quality of implementation • Positive/negative effects on target participants • Ability of participants to carry out intervention activities • Cost analysis
Adaptation	To what extent does an existing idea, program, process, or measure perform when changes are made for a new format or with a different population?	• Degree to which similar outcomes are obtained in new format • Process outcomes comparison between intervention use in two populations
Integration	To what extent can a new idea, program, process, or measure be integrated within an existing system?	• Perceived fit with infrastructure • Perceived sustainability • Costs to organization and policy bodies
Expansion	To what extent can a previously tested program, process, approach, or system be expanded to provide a new program or service?	• Fit with organizational goals and culture • Positive or negative effects on organization • Disruption due to expansion component

Area of focus	The feasibility study asks ...	Sample outcomes of interest
Limited efficacy	Does the a new idea, program, process, or measure show promise of being successful with the intended population, even in a highly controlled setting?	• Intended effects of program or process on key intermediate variables • Effect-size estimation • Maintenance of changes from initial change

¹ Reference 11 in the main reference list:

Bowen DJ, Kreuter M, Spring B, Cofta-Woerpel L, Linnan L, Weiner D, et al. How we design feasibility studies. Am J Prev Med. 2009;36(5):452–457. doi:10.1016/j.amepre.2009.02.002.

Chapter 7

Exploring Barriers and Facilitators for the Potential Implementation of the Decision Tool-Functional Independence in Primary Care

Esther Molenaar, Di-Janne Barten, Nienke Bleijenberg,

Niek de Wit, Cindy Veenhof

BMC Health Services Research

DOI: [10.1186/s12913-025-13000-4](https://doi.org/10.1186/s12913-025-13000-4)

ABSTRACT

Background: The aging population presents challenges for healthcare, particularly in maintaining the functional independence of older adults. The Decision Support Tool for Functional Independence was developed to identify declines in functional independence and promote collaboration between healthcare professionals. The DST-FI is specifically designed to support interprofessional collaboration between medical and social care providers, such as GPs, physiotherapists, nurses, and social workers. This study examines the barriers and facilitators to implementing the tool in primary care.

Methods: This study was conducted in the Netherlands and included thirteen healthcare professionals: general practitioners, physiotherapists, practice nurses, community nurses, occupational therapists, and social workers, as well as two focus groups with older adults. The study was guided by the Consolidated Framework for Implementation Research (CFIR). A combination of deductive and inductive thematic analysis was used to identify and explore barriers and facilitators to implementation.

Results: Key facilitators included the tool's potential to enhance collaboration, support informed decision-making, and address societal pressures related to aging. However, four main barriers emerged: limited applicability for specific client groups (e.g., individuals with cognitive impairments or low health literacy), time constraints, issues of ownership among stakeholders, and challenges in preventive outreach.

Conclusions: The diversity and complexity of factors influencing the implementation of the Decision Support Tool for Functional Independence highlight the need for multifaceted, tailored strategies. Future research should focus on developing customized approaches to overcome identified barriers, exploring adaptations for a broader audience, and determining the appropriate healthcare professionals for the tool's practical application. The potential of the tool to foster interprofessional collaboration between general practitioners, physiotherapists, nurses, and social workers, and alleviate societal challenges, emphasizing its relevance in primary care.

Keywords: Functional Independence · older persons · interprofessional collaboration · implementation

BACKGROUND

The aging of the population has significant implications for healthcare systems worldwide (1). As individuals age, they often experience a decline in physical functioning, resulting in decreased Functional Independence (FI) (2). FI is defined as functioning physically safely and independently from another person (3). This definition was developed through a scoping review and multidisciplinary stakeholder consultation to capture the full range of factors influencing FI. It aims to provide a shared understanding across professional domains. FI is a complex concept that not only depends on the level of physical capacity but also on personal factors such as health literacy and coping flexibility (4). Furthermore, contextual factors and safety, specifically addressing the risk of falls, also contribute to FI. In addition, community-dwelling older people want to stay in their own homes and make their living arrangements for as long as possible, instead of being relocated to supported housing (5,6). However, the decrease in FI often leads to increased dependency and the need for care and support services, causing major pressure on the healthcare system (7).

In addressing the challenges of the decreasing level of FI in older adults, a proactive focus on healthy aging is required (8). This includes early recognition of older persons at risk of losing their FI (9), which can be facilitated by monitoring FI over time among community-dwelling older people. To support this process and stimulate interprofessional collaboration, the Decision Support Tool for Functional Independence (DST-FI) was recently developed. Monitoring Functional Independence (FI) necessitates interprofessional collaboration, as FI is a multidimensional construct that transcends the boundaries of a single discipline. While its domains can be addressed independently by different professionals, effective coordination and collaboration are essential to meet the needs of older individuals (10)(11). At present, there is still room for improvement in interprofessional and multi-professional collaboration to further enhance the quality of care for older individuals (11).

The DST-FI was specifically designed for use by general practitioners, physiotherapists, practice nurses, and social workers in Dutch primary care. By providing a shared framework, the tool supports coordinated actions across these disciplines. In the Netherlands, primary care is characterized by the central role of general practitioners (GPs) as gatekeepers and coordinators, supported by allied health professionals and community-based services (12). Recently, the Decision Support Tool for Functional Independence (DST-FI), an interprofessional instrument for personalized assessment of FI, has been developed and validated. The DST-FI can help to better identify people with decreased FI, support tailored professional interventions, and stimulate interprofessional collaboration to prevent further decline of FI (13). The DST-FI tool shows promise in addressing barriers in interprofessional collaboration through facilitation of communication, clarification of roles and responsibilities, fostering mutual respect, and promoting a shared understanding of goals and objectives (16). The tool incorporates three essential components. First, measurement involves the use of the validated Core Outcome Set Functional Independence (COSFI), which determines the level of FI (14). Second, through matching, individuals are categorized into one of four established FI subgroups based on

their COSFI scores (13). Third, in the generation phase, tailored recommendations are provided, suggesting the most suitable healthcare professional(s) for their specific situation (15) (Figure 1).

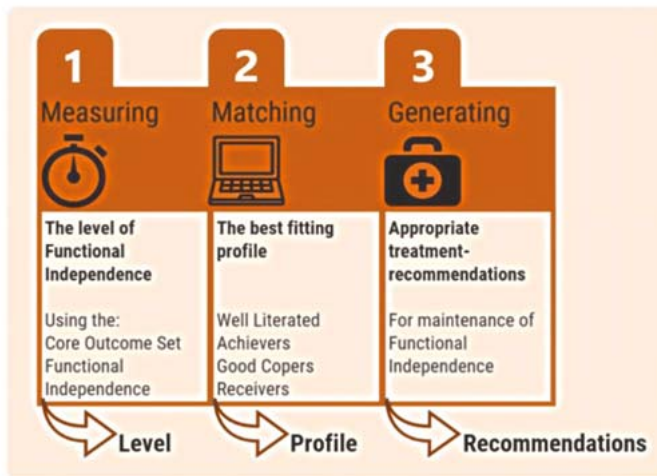


Figure 1 The Decision Support Tool for Functional Independence (DST-FI), designed for assessing Functional Independence (FI), incorporates three essential components: Measuring, Matching, and Generating.

The development of the DST-FI was part of a multi-phase research project, including a scoping review, expert consultations, psychometric validation of the COSFI, and co-design sessions with stakeholders. These steps provided the foundation for the current study, which focuses on the potential implementation of the tool in practice (3,14-16). Despite the potential of the DST-FI to facilitate professionals in supporting older adults in maintaining their FI, implementation has proven challenging so far. Prior studies emphasize the need for a systematic, evidence-based approach when implementing innovative tools such as the DST-FI in primary healthcare (17,18). In this process, mapping context-specific barriers and facilitators indicated by relevant stakeholders is the first crucial step for effective implementation. One of the most important factors influencing the implementation of decision tools such as the DST-FI in primary healthcare is individual professionals' motivation to incorporate the tool within their organizational setting. This is determined by the perceived added value of using the tool (19). This added value may be perceived in, for instance, improved work efficiency, allowing them to perform the same tasks with less effort or time. Another crucial factor is the perceived value to improve the quality of care for the patient (20). Moreover, an important condition for effective implementation is organizational support for the innovation, which includes alignment with the mission and management support (21). Lastly, financial and logistical support are the main facilitators for implementing prevention programs in Dutch primary care (22). While the mentioned requirements are generic, there are distinctive features of the DST-FI that demand specific attention. Firstly, the tool aims to encourage the involvement of multiple disciplines, fostering interprofessional collaboration. Secondly, it targets individual-level functional

independence (FI) decline and appropriate care. However, little is known about the practical conditions for implementing the DST-FI in primary care. Previous studies have not examined the perceived barriers and facilitators among the intended user groups. Therefore, make it the goal of the present study is to identify barriers and facilitators for the successful implementation of the DST-FI tool in Dutch primary care.

METHODS

Research Setting and Design

We used a qualitative exploratory design to gain insights into the barriers and facilitators experienced by multiple stakeholders regarding the use of the DST-FI tool in primary care (22). The study was part of an overarching research project (13) (4,13-15) aiming at the early identification of FI decline among community-dwelling older persons and the development, evaluation, and implementation of the DST-FI in a community (health)care setting in the Netherlands. At the time of the study, the DST-FI was still under development and not yet available for routine clinical use.

Participants and sampling

Healthcare professionals

Healthcare professionals were purposefully sampled based on a stakeholder analysis using the Interactive Systems Framework for Dissemination and Implementation (ISF)(23). The ISF describes three systems involved in implementation: Synthesis and Translation, Support, and Delivery. In previous projects, the research team has primarily operated within the Synthesis and Translation system. For this study, however, the focus shifted to understanding the roles and needs within the Delivery and Support systems, as these are most relevant for implementing the DST-FI in daily practice. Various primary care professionals from different settings, including mono-disciplinary primary care practices and multidisciplinary healthcare centers, were recruited. This included general practitioners, nurses, social workers, therapists, and sports coaches. Based on prior research and the Interactive Systems Framework (ISF), managers from the social domain and physiotherapy were specifically recruited due to their key roles in facilitating implementation processes (21). A flyer with a call to participate in the study, addressing Health Care and Social Care professionals and managers, was spread by e-mail within the network of the research group. In addition, the social media channels of the research group displayed the flyer.

Inclusion criteria for care professionals were: (1) working as a healthcare or social professional in primary care, and (2) working with the target group of individuals aged 65 and older. For healthcare management professionals, it was required that they be managers of care professionals treating individuals aged 65 and older. Eligible professionals who responded to the call received an information letter about the study at least one week before the interview took place, followed by a telephone call to schedule the interview appointment. Before the onset of the interview, participants signed informed consent.

Older adults

Additionally, two specific groups of individuals aged 65 and older were purposefully sampled. Physiotherapists within the researchers' network were requested to identify interested participants for one group and distribute the research invitations to them. In the case of the other group, invitations were sent directly to members of the Utrecht Elderly Care Network (NUZO). NUZO is a network comprising seniors and representatives from institutions in the fields of care and well-being (www.nuzo-utrecht.nl). It aims to stimulate and enhance the quality of life for seniors in the province of Utrecht, Netherlands. Inclusion criteria were: 1) age 65 or older and 2) sufficient understanding of the Dutch language. This approach was crucial for validating barriers and facilitators for instrument use among the target population. Similar to the professionals who participated in the study, eligible older adults signed informed consent before the onset of the focus group.

Data collection

Interview Framework

In this study, we used the Consolidated Framework for Implementation Research (CFIR) as the basis for our interview framework, as it offers a structured and comprehensive approach to assessing factors that influence implementation processes (24). CFIR consists of five domains: Innovation, Outer Setting, Inner Setting, Characteristics of Individuals, and Implementation Process. Each domain includes a range of constructs that help explore barriers and facilitators at different levels of an implementation environment. Based on existing literature on the implementation of similar decision support tools, we selected three domains: Innovation, Outer Setting, and Individual, as the most relevant for this study context. This focused selection was made to ensure content relevance while minimizing respondent burden (25). The selected domains and constructs informed both the design of our interview guide and the subsequent analysis. In our study, the Innovation domain referred to perceived characteristics of the DST-FI itself (e.g., usability, adaptability); the Outer Setting captured contextual factors such as patient needs and inter-organizational collaboration; and the Individual Characteristics domain focused on professionals' knowledge, attitudes, and self-efficacy regarding the tool. (19-22).

Table 1 Selected domains and associated constructs from The Consolidated Framework for Implementation Research Consolidation Framework (CFIR), including its definitions (Interview Guide Tool (available at <https://cfirguide.org/guide/app/#/>).

Implementation domains	Implementation Construct	Definition
Innovation domain	Innovation Relative advantage	Stakeholders' perception of the advantage of implementing the intervention versus an alternative solution.
	Innovation Evidence Base	
	Innovation Adaptability	The degree to which an intervention can be adapted, tailored, refined, or reinvented to meet local needs.
	Innovation Complexity Innovation Design	Perceived excellence in how the intervention is bundled, presented, and assembled.
	Innovation Cost	Costs of the intervention and costs associated with implementing that intervention including investment, supply, and opportunity costs.
Individuals domain	Roles	The roles applicable to the project and their location in the Inner setting or Outer setting
	Knowledge & Beliefs about the Intervention	Individuals' attitudes toward and value placed on the intervention as well as familiarity with facts, truths, and principles related to the intervention.
	Self-efficacy	Individual belief in their own capabilities to execute courses of action to achieve implementation goals.
	Individual Stage of Change	Characterization of the phase an individual is in, as he or she progresses toward skilled, enthusiastic, and sustained use of the intervention.
	Other Personal Attributes	
Outer Setting domain	Patient Needs & Resources	Coding between Tension for Change, Relative Advantage, and Needs and Resources of Those Served by the Organization.
	Tension for Change	Statements that demonstrate a strong need for the intervention and/or that the current situation is untenable.
	Relative Advantage	Statements that demonstrate the intervention is better (or worse) than existing programs.
	Needs and Resources	Statements regarding specific needs of individuals that demonstrate a need for the intervention but do not necessarily represent a strong need or an untenable status quo.

The interview guide for all participants utilized questions derived from the CFIR Interview Guide Tool (IGT)(26). The interview questions were translated into Dutch and culturally adapted to suit the specific stakeholder context by the first author. Additionally, the questions underwent peer review by the other authors. The interview guide is presented in Appendix A.

Interviews with professionals

Structured interviews according to the prepared interview guide explored participants' perceptions of barriers and facilitators to the use of the DST-FI tool in usual care. Guided prompts enabled gathering more information. These prompts consisted of sections from the DST-FI prototype, and a demonstration model of the prototype was presented to clarify the usage of the DST-FI tool. The main focus of each interview varied depending on the participant's role; Interviews with professionals in management positions focused on identifying barriers and facilitators at the management level and explored the integration of the innovation within the organizational context (CFIR outer setting and innovation domain). Conversely, interviews with healthcare professionals highlighted individual motivation, the role of the individual, and the perceived added value of the innovation for both the individual and their patients (CFIR individual domain and innovation domain).

Iterative adaptation of the interview guide after each interview allowed for a deeper understanding of facilitators and barriers, as adjustments were made to enhance contextual responsiveness and collect more comprehensive and relevant data (27). The process of participant inclusion was concluded when theoretical saturation was reached, indicating that no new information was obtained from subsequent interviews (28). This applied to the overall participant group; saturation could not be claimed for the small subgroup of managers. Face-to-face interviews, both online and in-person, lasted approximately one hour and were audio-recorded.

Focus groups with older individuals

Additionally, structured focus group meetings were conducted with the two groups of older individuals. These focus group discussions, lasting approximately one hour each, were audio recorded. The focus of these group conversations primarily centered on the practical perspectives of utilizing the tool within the target population of community-dwelling older people. This encompassed aspects such as the measurement process and the referral process, both aimed at promoting functional independence among community-dwelling older individuals.

The first author (EM), with prior experience in conducting interviews, conducted all the interviews. Additionally, before commencing the interviews, a test interview was conducted to assess the translation of the questions into Dutch. To further enhance the interviewing skills of the first author, feedback was sought from two experienced colleagues regarding the questioning style and probing techniques. The interviewer had no prior acquaintance with the professionals or involvement in the care of older persons.

Analysis

Audio recordings of both interviews with professionals and focus groups with older adults were first transcribed verbatim. After pseudonymization, where each participant was assigned a unique pseudonym, personal information was de-identified, preserving data integrity for analysis and

reporting purposes. The pseudonyms, known only to the research team, were securely stored separately from the collected data to ensure anonymity. When participants agreed to this, a member check was conducted, and relevant information suggested by the participants was incorporated into the analysis to enhance its comprehensiveness.

We used a combination of inductive and deductive methods to analyze the derived data. Data collection and analysis occurred in an iterative manner, allowing insights from early interviews to inform subsequent data collection and interpretation. Although the coding was partly guided by three predefined CFIR constructs: intervention characteristics, inner setting, and characteristics of individuals, the overall analytic approach was interpretive in nature. This allowed for the identification of additional CFIR constructs as well as factors beyond the CFIR framework, enabling a richer understanding of underlying meanings and patterns. The process of data analysis is presented in Figure 2.

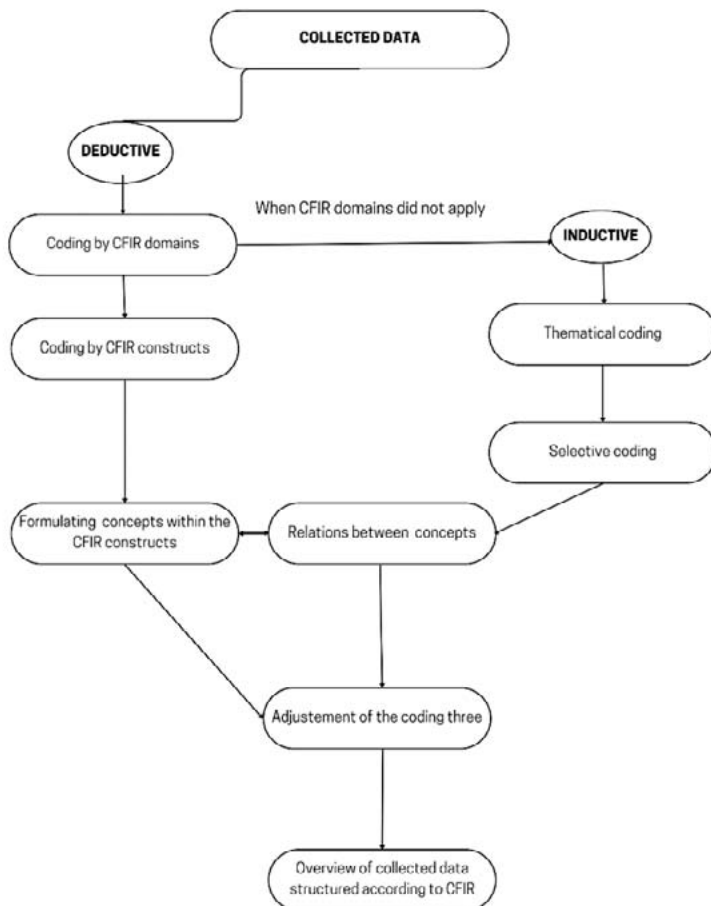


Figure 2 Schematic representation of the analysis process, involving a combination of inductive and deductive analysis methods, aimed at mapping barriers and facilitators associated with the implementation of the DST-FI tool.

Initially, a deductive analysis to identify emerging themes and sub-themes from the data was performed (29,30). When data fragments appeared significant but did not directly align with the domains from the CFIR-based code tree, they were analyzed inductively. Based on this analysis, themes from the deductive and inductive analyses were merged, and new themes were added. This approach allows themes to emerge directly from the data and accommodates themes that fall outside the scope of CFIR but are still relevant to the implementation of the DST-FI. It also considers the broader context of the literature by utilizing the CFIR framework. To ensure interrater agreement, the second coder (DB) independently coded 10% of the transcripts. Discussions with members of the research team on the emerging analysis further validated the rigor of the qualitative analysis. A consensus approach was used to build agreement about the emerging themes, with any disagreements resolved by discussion and review of the data and coding. During team discussions,

the emerging thematic analysis was considered to CFIR and deductively organized by the relevant CFIR domain areas. Subsequently, the potential themes were reviewed and reorganized. The first and second authors refined and named the themes and subthemes, resulting in a final overview of potential barriers and facilitators. Only the themes relevant to the development and implementation of the DST-FI tool in the current context of older persons in primary care were retained for the final selective presentation and analysis. This selective approach allowed for a more comprehensive and nuanced exploration of the identified barriers and facilitators concerning the context of interest (30). The qualitative data were analyzed using Atlas.ti software (version 23.3.4) (31).

Ethical considerations

The Medical Research Involving Humans Act (Dutch: WMO) did not apply to this research because it does not relate to medical scientific research, participants are not subjected to procedures or required to follow rules of conduct, and there is no violation of the physical and/or psychological integrity of the subjects. Written informed consent from respondents was obtained before they participated in the interviews, which were conducted between March and September 2023.

RESULTS

Characteristics of participants

The study included thirteen healthcare professionals. Participants were one general practitioner, four (geriatric) physiotherapists, three (district) nurses, three occupational therapists, one manager in the social domain, and one in the health care domain. Additionally, two focus groups were conducted, with a total of eight participants aged 65 and above (N=4 and N=4). Years of experience were not part of the formal inclusion criteria, but were considered during recruitment to ensure diversity of perspectives. A comprehensive overview of participant characteristics is available in Tables 2a and 2b.

Table 2a: Overview of health care professionals included in the study on barriers and facilitators for the implementation of the Decision Support Tool - Functional Independence.

Participant pseudonym	Profession	Work experience	Work setting	Gender
GPT 1	Physical therapist specialized in geriatrics and board member Professional Association Geriatric Physiotherapy	5-10 years	Primary care	Male
PN	Practice nurse for general practitioner	>10 years	Primary care	Female
CN 1	Community nurse	< 5 years	Primary care	Female
GPT 2	Physical therapist specialized in geriatrics	>10 years	Secondary care	Female
GP	General practitioner	5-10 years	Primary care	Female
PT 1	Physical therapist and Manager of Physiotherapy	>10 years	Primary care	Male
MSW	Manager in social work	>10 years	Primary care	Male
PT2	Physical Therapist	<5 years	Secondary care	Female
PT 3	Physical Therapist	<5 years	Primary care	Male
OT 1	Occupational therapist	>10 years	Primary care	Female
OT2	Occupational therapist	<5 years	Primary and Secondary care	Female
OT3	Occupational therapist	5-10 years	Primary care	Female
CN 2	Community nurse specialist	>10 years	Primary care	Female

Abbreviations: GPT = Geriatric Physical Therapist; PT = Physical Therapist; PN = Practice Nurse; GP = General Practitioner; CN = Community Nurse; OT = Occupational Therapist; MSW = Manager in Social Work

Table 2b: Overview of older persons included in the study on barriers and facilitators for the implementation of the Decision Support Tool - Functional Independence.

Group	Setting	Male/Female	Age (years)
OP group 1	Therapeutic Exercise Group in a Physiotherapy Practice	0/4	70-91
OP group 2	Utrecht Elderly Care Network	1/3	70-75

Abbreviation: OP = Older persons

Study outcomes

A diverse range of themes emerged from the interviews with professionals and older individuals as barriers or facilitators for the implementation of the DST-FI, encompassing virtually the entire spectrum of constructs within the CFIR domains. While our interview framework was initially based on three selected CFIR domains, additional domains, such as Inner Setting, emerged inductively during analysis and were therefore incorporated into the final results. To improve clarity, Figure 3 presents only the identified themes categorized within the three CFIR domains selected for this study: Innovation, Outer Setting, and Individual Characteristics. Additional themes that emerged in relation to other domains (e.g., Inner Setting and Process) are included in Appendix B.

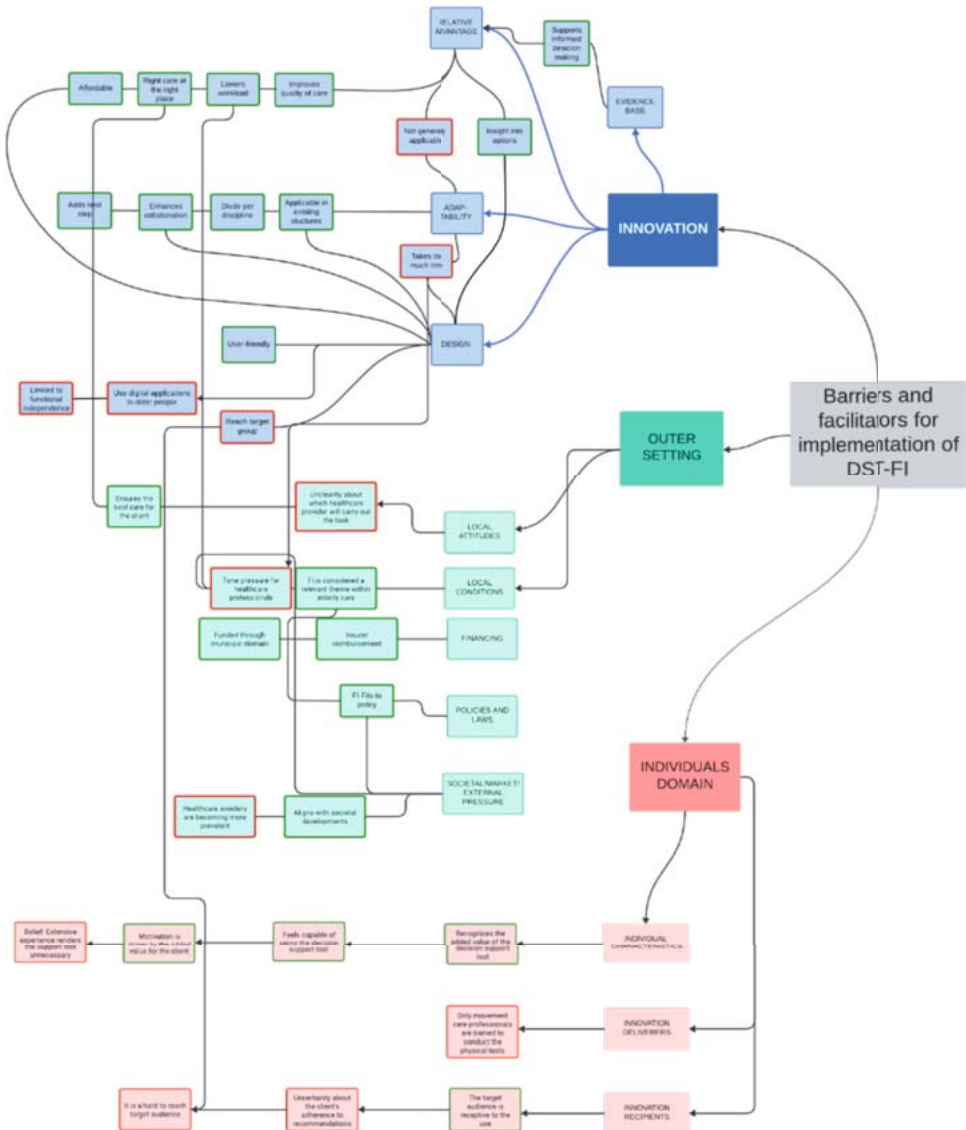


Figure 3: Overview of barriers and facilitators categorized by the selected CFIR domains.

To provide a focused and practically relevant overview, we selected three key barriers and three key facilitators to present in detail. This selection was based on a matrix developed by the first two authors, in which all identified themes were scored on relevance to current practice, frequency across stakeholder groups, and perceived urgency as expressed by participants. The highest-scoring themes were discussed with the research team, and final selection was based on group consensus. Facilitating themes included the tool's potential to support well-informed decision-making and

enhance multi- and interprofessional collaboration. While these are characteristics of the DST-FI itself, participants perceived them as potentially supportive of implementation. In addition, alignment with societal and policy developments was identified as a broader facilitating factor. Reported barriers included the lack of a concrete follow-up step, time constraints, unclear ownership among stakeholders, and challenges in reaching the target population preventively. These themes were further explored in detail, meaning that we analyzed their position within the CFIR and attempted to establish relationships with other domains and themes. Additionally, to illustrate these themes corresponding to the CFIR constructs, we provide quotes from different participants.

Facilitators to the implementation of the DST-FI tool

Addressing Associated Societal Pressures

A facilitating theme for the potential implementation of the DST-FI instrument encompasses a large portion of the constructs within the outer setting domain, such as local attitudes, policies and laws, and societal/external market pressure. Participants indicate that FI aligns with societal developments, healthcare policy, and institutional policy, and is considered relevant within care for older persons. This conviction of the participants emphasizes the relative advantage of the innovation, which could motivate them to use the tool in practice.

Older persons group 1: “There should be more attention from the government for ageing and prevention. It’s time we take this seriously.”

Geriatric Physical Therapist 1: “I believe that obtaining Functional Independence or maintaining Functional Independence is of vital importance in current societal developments, as long as we can help individuals retain or regain their Functional Independence.” “This significantly reduces the demand on the healthcare sector.”

Moreover, participants expressed a belief that through the use of the tool, they can contribute to what they consider a significant societal issue.

Physical Therapist 3: “I think it’s very useful that there is consideration given to addressing this issue, as I believe it’s a common problem for older individuals to remain in a situation that is not safe or okay for too long, and that could potentially have been prevented. I believe this tool could contribute to the prevention of such situations.”

Potential for Multi and Interprofessional Collaboration

Another theme that could enhance the implementation of the DST-FI tool is its potential contribution to interprofessional collaboration. Several participants highlighted the need for improvement in this collaboration area and acknowledged its urgency in their current work situation. The overview (Figure 3) illustrates an interaction between the Inner Setting: Tension for Change, Relational

Connections, and the Relative Priority. Prioritizing the improvement of multi- and interprofessional collaboration could facilitate the implementation process.

General Practitioner: “Yes, the Community Sports Coordinator, we do know who it is, but at the moment, we don’t have sufficient contact with them, I think. It’s something we’re working on to improve.”

Physical Therapist 3: “I also work in another department, and there we actually have no meetings or coordination, and we often work in isolation, which sometimes results in longer patient stays due to the delay in decision-making. You have to wait for an available spot, incurring additional healthcare costs and burdening the patient.”

Older Persons Group 1: “Collaboration. ‘Those professionals should be able to work together right now it’s going in different directions.”

Well-informed Decision-Making

Participants highlighted the importance of using an evidence-based innovation, offering a clear advantage compared to current practices. The innovation’s design presents various options and the rationale behind choices, fostering ‘the right care at the right place’ and enhancing overall care quality. Moreover, the tool’s evidence-based content informs professionals about different possibilities, promoting shared decision-making. This multifaceted function not only highlights a relative advantage over existing practices but also emphasizes the tool’s potential to enhance patient care, thereby motivating professionals to adopt it, driven by the added value for the patient in the individual domain.

Occupational therapist 1: “I think the decision support tool can provide valuable guidance in determining the relevance of various healthcare professionals for the patient”.

Physical Therapist 1: “Yes, the tool certainly makes things clearer and more concrete in terms of the basis for your decisions. I believe that, at the moment, we come up with many things implicitly or in our minds, but we likely have blind spots.”

Older Persons Group 1: “I think it really adds value, because it’s a structured assessment. That makes it feel more serious and useful.”

Older Persons Group 2: “I think the added value lies in that, you know. That you have multiple sub-areas. So, you conduct a systematic investigation. Consequently, you get a realistic representation at that moment of the situation the older person is in. I think that’s the beauty of it. The coherence.”

Barriers to the implementation of the DST-FI tool

Limited Applicability

A theme that emerged from both the innovation domain (adaptability) and the inner setting domain (compatibility) is that professionals considered the tool less applicable for a portion of the population they encounter in practice, for instance, individuals with cognitive problems or diminished health literacy skills. To increase the practical feasibility of the DST-FI's recommendations for these groups, participants proposed incorporating a concrete follow-up step. This refers to including clear, actionable next steps, such as the name and contact details of a relevant professional (e.g., a local physical activity coach), or even facilitating the referral process directly. They indicate that the added value of using the tool in practice is related to the number of individuals for whom they can employ the tool. They believe this adjustment would make it more likely for them to use the tool, as it could then be applied to a larger portion of the population.

Physical Therapist 3: "If you want to stimulate Functional Independence, you would naturally say: make the appointment yourself and call the physiotherapist yourself, maybe providing a phone number for one nearby or suitable. But if you want to reach the more passive population, it might be better to arrange it for someone because they might otherwise think more quickly: well, I'm not interested in that, I can't do it all."

Time

Professionals express a negative stance toward the use of an additional tool, emphasizing the necessity for integrating the DST-FI tool into existing healthcare processes and systems to ensure its efficiency. From both the inner and outer settings, the constraint of time was mentioned. External pressures and local conditions in the outer setting create time and workload pressure on healthcare professionals. Similarly, within the inner setting, a culture prevails where there is a substantial amount of work with limited time available. This contributes to tension for change, indicating a need for a more effective way of working

Physical Therapist 1: "General practitioners are simply terribly busy. Occasionally, we do more frequent, shorter visits. But, in reality, we don't have time to add these kinds of extensive things to our workload". Well, in terms of time, it can help to carefully examine what is already included in the existing screening tools and what is here".

Ownership

Another theme that could negatively impact the potential use of the DST-FI tool is identified in the individuals' domain, encompassing both individual characteristics and innovation deliverers. The findings reveal uncertainty about the intended professional for administering the DST-FI tool. The results distinctly show a divergence between professionals in the field of physical therapy and other disciplines, with physical therapists feeling capable of administering the DST-FI tool, while those in other disciplines do not feel capable and consider the administration of the associated tests outside

their scope. Many participants expressed that physical therapists are perceived as the intended professionals for administering the tool. If participants do not see themselves as the intended professionals for implementing the DST-FI tool, they are less likely to adopt it.

Physical therapist specialized in geriatrics 1: “Which professional should use this decision support tool?”

Occupational therapist 2: “... those tests, that’s physiotherapy, I cannot administer them, am not allowed to administer them, or it should be specifically done by a physiotherapist.”

Potential for Preventive Population Outreach

Participants expressed the value of using the tool preventively to maintain Functional Independence in older adults in the community. However, they expressed concerns about reaching this target population, which could be associated with the Innovation Recipients domain (figure 3). They voiced doubts about the preventive use of the tool, as this group might be resistant to its adoption. Quotes concerning this theme emerged from the data and could not directly be coded using the deductive coding approach but were eventually added to the comprehensive model through inductive analysis (Figure 3).

Practice nurse: “How do we identify these people? That’s really what we’re busy with here.”

Physical Therapist 1: “Of course, we also have older persons who are very stubborn and refuse to accept any advice. While you’re thinking, this is clearly not going well, and it’s going to be a major crisis if help doesn’t arrive sooner.”

DISCUSSION

This exploratory qualitative study aimed to map potential barriers and facilitators relevant to implementing the novel DST-FI tool in the specific Dutch primary care context. A total of seven themes emerged, with 3 themes indicating potential facilitators and 4 themes pointing to potential barriers to the implementation of the tool. This study highlights the complexity of implementing this tool, where determinants across different domains are interconnected and mutually influence one another, furthermore emphasizing the challenge of successful implementation in the community since there is not one single theme that can be identified as a key barrier or facilitator (39).

Potential facilitators

Two facilitators found in this study, i.e., “potential for multi- and interprofessional collaboration” and “well-informed decision-making”, originated from the CFIR domain “Innovation” based on the constructs of relative advantage, evidence base, and design. These findings highlight how aspects of the healthcare innovation may influence potential implementation. Characteristics that offer a relative advantage compared to the current situation are considered incentives for the

implementation of the innovation (32). Our findings on the importance of these different aspects of the DST-FI tool are consistent with studies that have examined how intervention features, such as evidence-based action based on measurement data, could positively influence implementation (33,34). Additionally, the third facilitator identified in this study, which was addressing associated societal pressures, aligns with the literature suggesting that characteristics in the ‘Outer Setting,’ including ‘Patient Needs’ and ‘External Policy,’ may positively influence the utilization of a tool like the DST-FI tool in practice (33,35). Overall, these facilitators may influence individual healthcare professionals to consider adopting the tool. This is consistent with existing literature, emphasizing the significant influence of individuals’ motivation throughout the implementation process of healthcare innovations (36). In addition, Cooper et al. identified in their review on implementing community-based physical activity interventions several studies emphasizing that positive attitudes and beliefs contribute to successful implementation (37-39). When individuals implementing the intervention recognize the value of the intervention, they act as key facilitators for successful implementation (40).

Potential barriers

Although the CFIR domain “Innovation” revealed several facilitating themes, respondents indicated that there are also aspects of the innovation that may harm the practical use of the tool. The absence of a concrete follow-up step in the design of the tool could hinder its broad applicability in practice. This undermines the potential added value of the innovation in practice, whereas this added value is considered a crucial facilitator for implementation (41). In addition, an important barrier is time (inner setting domain). The tool’s integration within the work processes of healthcare professionals emerges as a crucial theme for successful implementation. This is in line with existing literature indicating that an implementation strategy, involving the adaptation and integration of a health innovation into the established work organization, is more likely to be successful compared to an approach where such integration is lacking (42,43). This is necessary due to the increased workloads recognized in this study for healthcare professionals and the limited time available, specifically in the care of older patients (44). Furthermore, the barriers associated with the ‘ownership’ theme, within the CFIR ‘Individuals’ domain, could be minimized by integrating them into the regular care provided by the physical therapist. Participants indicate that this professional is already familiar with the physical tests included in the DST-FI tool, making them the most feasible option in terms of both time and cost efficiency. The significance of time as a potential barrier in the implementation process within the healthcare landscape is consistent with previous research conducted by Pratt et al., who investigated the implementation of a web-based clinical decision support tool designed to identify and provide care recommendations in primary care. (19). Lastly, a barrier encompassing multiple CFIR domains is “preventive population outreach.” This means that professionals emphasize the importance of being able to use the tool preventively; however, they point out that they do not come across this segment of the target population in practice. This poses a challenge in implementing the tool for these individuals, as reaching the target group for preventive measures is known to be difficult, as highlighted in the literature (8).

Strengths and limitations

This explorative qualitative study using the CFIR has two noteworthy methodological concerns, and, conversely, it possesses three strengths. The first strength of the study lies in using the CFIR to guide our analysis. The framework was instrumental in efficiently identifying and organizing data across domains that evidence shows have a significant impact on implementation effectiveness (45). Therefore, our research emphasizes the usefulness of employing the CFIR for a systematic evaluation of facilitators and barriers to implementing innovations in primary care. A methodological concern relates to the comprehensive nature of the CFIR domains, which may have contributed to a more abstract level of analysis. This broad scope may, at times, make it difficult to capture highly specific, context-dependent insights related to the studied innovation. Rather than interpreting this as a limitation of the framework itself, we regard it as a reflection of the way in which the framework was applied in this particular context. The second strength results from integrating the coding with the derived CFIR codebook and incorporating inductive analysis of themes not directly aligning with the CFIR-guided codebook. This approach contributed to expanding our findings by comparing interpretations from diverse perspectives. The second methodological consideration relates to the fact that the CFIR does not prescribe which domains or constructs are most relevant for a particular implementation context(46). As a result, the research team made deliberate choices about which themes to highlight in the findings, based on relevance and consensus (47). Lastly, the third strength of the study lies in the composition of the study population. To enhance objectivity and mitigate potential bias, we deliberately included diverse representatives from the ISF. Prior research underscores the pivotal role of end-users as stakeholders for healthcare professionals, emphasizing their focus on patient satisfaction and the personal goal of delivering optimal care (47). In line with this, we incorporated a group of older individuals to validate the barriers identified by healthcare professionals and explore the potential use of the tool in clinical practice. This approach allowed us to confirm whether the barriers indicated by healthcare professionals were realistic when considering the perspective of older individuals, providing valuable insights into the potential challenges (48). While efforts were made to recruit older adults, we were able to include only a small number, divided across two diverse focus groups. Moreover, participants were recruited via the researchers' professional network, which may have introduced a degree of selection bias and limited diversity within the sample. These factors may restrict the generalizability of findings related to this stakeholder group. At the same time, we emphasize that older adults were included to validate and contextualize the perspectives of healthcare professionals. Their input provided valuable insights into whether the barriers identified by professionals were realistic and relevant from the user's perspective. In a later stage of the implementation process, policymakers and institutional board members should be involved, especially when exploring options to use the DST-FI tool outside the regular treatment provided by physiotherapists. In addition to the involvement of relevant stakeholders, it is important to consider the broader healthcare context in which the DST-FI is to be implemented. The Dutch primary care system is characterized by a fragmented organization of services and varying levels of interprofessional collaboration across regions. While national policy increasingly emphasizes prevention and the promotion of functional independence, actual implementation often depends

on local networks, professional ownership, and available resources (12). The DST-FI appears to align well with these policy goals, but regional variability may pose challenges to uniform implementation (49). This highlights the importance of tailoring implementation efforts to local conditions and contexts. Finally, it should be noted that the transferability of these findings may be limited. They are closely tied to the structure and organization of Dutch primary care and to the specific composition of the study population. As such, caution is advised when applying these insights to different healthcare systems or international settings.

Recommendations

Future research should focus on selecting and designing implementation strategies tailored to the specific barriers and facilitators identified in this study. For example, strategies emphasizing the distinct benefits for professionals in practice, such as the tool's potential to foster interprofessional collaboration, could be strengthened through approaches like "Promote network weaving" or "Identify and prepare champions", as described in the ERIC (Expert Recommendations for Implementing Change) taxonomy (50). Additionally, the tool should be adapted to apply to a broad target audience, for example, by incorporating a concrete follow-up step, such as providing contact information or initiating direct referrals. This adjustment would enhance the tool's usability for healthcare professionals in practice. A final recommendation would be to select the most appropriate healthcare professional for using the tool and to develop further policies based on this choice. Strategies like "Clarify professional roles" and "Revise professional workflows" may aid in this process (50).

Conclusions

This study outlines barriers and facilitators specifically relevant to the implementation of the DST-FI tool in the current context of older persons in primary care. The most important facilitators focused on the potential for collaboration, well-informed decision-making, and addressing societal pressures. Four identified barriers encompassed limited applicability, time constraints, ownership issues, and challenges in preventive outreach. The diversity and complexity of themes affecting the implementation of the DST-FI tool underscore the need for multifaceted strategies tailored to the barriers and facilitators present in the specific context. Future research should focus on tailored implementation strategies, adaptation for a broader audience, and selecting suitable healthcare professionals for using the DST-FI tool in practice, given its potential to stimulate collaboration between professionals and address societal pressures.

List of abbreviations

COSFI: Core Outcome Set Functional Independence

DST-FI: Decision Support Tool for Functional Independence

FI: Functional Independence

CFIR: Consolidated Framework for Implementation Research

DST-FI: Decision Support Tool for Functional Independence

ISF: Interactive Systems Framework for Dissemination and Implementation

NUZO: Utrecht Elderly Care Network

REFERENCES

1. Lunenfeld B, Stratton P. The clinical consequences of an ageing world and preventive strategies. *Best Pract Res Clin Obstet Gynaecol* 2013 Oct;27(5):643–659.
2. Candela F, Zucchetti G, Magistro D. Individual correlates of autonomy in activities of daily living of institutionalized elderly individuals: an exploratory study in a holistic perspective. *Holist Nurs Pract* 2013;27(5):284–291.
3. Molenaar EALM, Barten JA, te Velde S, van der Schoot L, Bleijenberg N, de Wit NJ, et al. Functional Independence in the Community Dwelling Older People: a Scoping Review. *Journal of Population Ageing* 2023;16(1):243–262.
4. Molenaar EALM, Barten JA, te Velde S, van der Schoot L, Bleijenberg N, de Wit NJ, et al. Functional Independence in the Community Dwelling Older People: a Scoping Review. *Journal of Population Ageing* 2020.
5. Harrefors C, Sävenstedt S, Axelsson K. Elderly people's perceptions of how they want to be cared for: an interview study with healthy elderly couples in Northern Sweden. *Scand J Caring Sci* 2009 Jun;23(2):353–360.
6. King G, Farmer J. What older people want: evidence from a study of remote Scottish communities. *Rural Remote Health* 2009;9(2):1166.
7. de Wit NJ, Schuurmans MJ. Future care for older people in general practice: paradigm shifts are needed. *Br J Gen Pract* 2017 Nov;67(664):500–501.
8. Bleijenberg N, Drubbel I, Schuurmans MJ, Dam Ht, Zuithoff NPA, Numans ME, et al. Effectiveness of a Proactive Primary Care Program on Preserving Daily Functioning of Older People: A Cluster Randomized Controlled Trial. *J Am Geriatr Soc* 2016;64(9):1779–1788.
9. van Blijswijk SCE, Blom JW, de Craen AJM, den Elzen WPJ, Gussekloo J. Prediction of functional decline in community-dwelling older persons in general practice: a cohort study. *BMC Geriatr* 2018 Jun 11;18(1):140–z.
10. Reeves S, Pelone F, Harrison R, Goldman J, Zwarenstein M. Interprofessional collaboration to improve professional practice and healthcare outcomes. *Cochrane Database of Systematic Reviews* 2017(6).
11. Supper I, Catala O, Lustman M, Chemla C, Bourgueil Y, Letrilliart L. Interprofessional collaboration in primary health care: a review of facilitators and barriers perceived by involved actors. *Journal of public health* 2015;37(4):716–727.
12. Kroneman M, Boerma W, van den Berg M, Groenewegen P, de Jong J, van Ginneken E. Netherlands: Health System Review. *Health Syst Transit* 2016 Mar;18(2):1–240.
13. Molenaar EALM, Barten DJ, de Hoop AMS, Bleijenberg N, de Wit NJ, Veenhof C. Cluster analysis of functional independence in community-dwelling older people. *BMC Geriatr* 2022 Dec 23;22(1):996–2.
14. Dockx YJC, Molenaar EALM, Barten DJA, Veenhof C. Discriminative validity of the Core outcome set functional independence in a population of older adults. *BMC Geriatr* 2020 Aug 26;20(1):309–6.
15. van Bijsterveld SC, Barten JA, Molenaar EALM, Bleijenberg N, de Wit NJ, Veenhof C. Psychometric evaluation of the Decision Support Tool for Functional Independence in community-dwelling older people. *J Popul Ageing* 2022 Mar 29:1–23.
16. Molenaar EALM, Barten DJ, de Hoop AMS, Bleijenberg N, de Wit NJ, Veenhof C. Cluster analysis of functional independence in community-dwelling older people. *BMC Geriatr* 2022 Dec 23;22(1):996–2.
17. Fernandez ME, Ten Hoor GA, Van Lieshout S, Rodriguez SA, Beidas RS, Parcel G, et al. Implementation mapping: using intervention mapping to develop implementation strategies. *Frontiers in public health* 2019;7:158.
18. Huynh AK, Hamilton AB, Farmer MM, Bean-Mayberry B, Stirman SW, Moin T, et al. A pragmatic approach to guide implementation evaluation research: strategy mapping for complex interventions. *Frontiers in public health* 2018;6:134.
19. Pratt R, Saman DM, Allen C, Crabtree B, Ohnsorg K, Sperl-Hillen J, et al. Assessing the implementation of a clinical decision support tool in primary care for diabetes prevention: a qualitative interview study using the Consolidated Framework for Implementation Science. *BMC Medical Informatics and Decision Making* 2022;22(1):15.
20. Harry ML, Truitt AR, Saman DM, Henzler-Buckingham HA, Allen CI, Walton KM, et al. Barriers and facilitators to implementing cancer prevention clinical decision support in primary care: a qualitative study. *BMC Health Serv Res* 2019 Jul 31;19(1):534–4.
21. Driessen MT, Groenewoud K, Proper KI, Anema JR, Bongers PM, van der Beek AJ. What are possible barriers and facilitators to implementation of a Participatory Ergonomics programme? *Implementation Science* 2010;5(1):64.
22. Vos HMM, Adan IMA, Schellevis FG, Lagro-Janssen ALM. Prevention in primary care: facilitators and

- barriers to transform prevention from a random coincidence to a systematic approach. *J Eval Clin Pract* 2014 Jun;20(3):208–215.
23. Wandersman A, Duffy J, Flaspohler P, Noonan R, Lubell K, Stillman L, et al. Bridging the Gap Between Prevention Research and Practice: The Interactive Systems Framework for Dissemination and Implementation. *Am J Community Psychol* 2008;41(3):171–181.
 24. Damschroder LJ, Reardon CAO, Widerquist MAO, Lowery J, Sci I. The updated Consolidated Framework for Implementation Research based on user feedback. *Implementation science : IS JID - 101258411*.
 25. Kirk MA, Kelley C, Yankey N, Birken SA, Abadie B, Damschroder L. A systematic review of the use of the Consolidated Framework for Implementation Research. *Implementation Science* 2016;11(1):72.
 26. Breimaier HE, Heckemann B, Halfens RJ, Lohrmann C. The Consolidated Framework for Implementation Research (CFIR): a useful theoretical framework for guiding and evaluating a guideline implementation process in a hospital-based nursing practice. *BMC nursing* 2015;14:1–9.
 27. Guest G, Namey E, Chen M. A simple method to assess and report thematic saturation in qualitative research. *PloS one* 2020;15(5):e0232076.
 28. Bernard HR, Wutich A, Ryan GW. Analyzing qualitative data: Systematic approaches. : SAGE publications; 2016.
 29. Moser A, Korstjens I. Series: Practical guidance to qualitative research. Part 3: Sampling, data collection and analysis. *European journal of general practice* 2018;24(1):9–18.
 30. Braun V, Clarke V. Using thematic analysis in psychology. *Qualitative research in psychology* 2006;3(2):77–101.
 31. Muhr T. ATLAS. ti Scientific software development GmbH. User's manual for ATLAS.ti 1998;5.
 32. GROUPE RPTM, BOSCH MC, HULSCHER MEJL, ECCLES MP, WENSING M. Planning and Studying Improvement in Patient Care: The Use of Theoretical Perspectives. *Milbank Q* 2007;85(1):93–138.
 33. Lam H, Quinn M, Cipriano-Steffens T, Jayaprakash M, Koebnick E, Randal F, et al. Identifying actionable strategies: using Consolidated Framework for Implementation Research (CFIR)-informed interviews to evaluate the implementation of a multilevel intervention to improve colorectal cancer screening. *Implementation Science Communications* 2021;2(1):57.
 34. Illott I, Gerrish K, Booth A, Field B. Testing the Consolidated Framework for Implementation Research on health care innovations from South Yorkshire. *J Eval Clin Pract* 2013 Oct;19(5):915–924.
 35. Silver S, Jones KC, Redmond S, George E, Zornes S, Barwise A, et al. Facilitators and barriers to the implementation of new critical care practices during COVID-19: a multicenter qualitative study using the Consolidated Framework for Implementation Research (CFIR). *BMC Health Serv Res* 2023 Mar 20;23(1):272–w.
 36. Cooper J, Murphy J, Woods C, Van Nassau F, McGrath A, Callaghan D, et al. Barriers and facilitators to implementing community-based physical activity interventions: a qualitative systematic review. *Int J Behav Nutr Phys Act* 2021 Sep 7;18(1):118–w.
 37. Sims-Gould J, McKay HA, Hoy CL, Nettlefold L, Gray SM, Lau EY, et al. Factors that influence implementation at scale of a community-based health promotion intervention for older adults. *BMC Public Health* 2019;19(1):1619.
 38. Draper CE, Kolbe-Alexander T, Lambert EV. A Retrospective Evaluation of a Community-Based Physical Activity Health Promotion Program. *Journal of Physical Activity and Health* 2009;6(5):578–588.
 39. Judith S B de M, Wal MFvd, Willem vM, Mai JMC. A Mixed Methods Process Evaluation of the Implementation of JUMP-in, a Multilevel School-Based Intervention Aimed at Physical Activity Promotion. *Health Promotion Practice* 2013;14(5):777–790.
 40. Cooper J, Murphy J, Woods C, Van Nassau F, McGrath A, Callaghan D, et al. Barriers and facilitators to implementing community-based physical activity interventions: a qualitative systematic review. *International Journal of Behavioral Nutrition and Physical Activity* 2021;18(1):118.
 41. Chen W, O'Bryan CM, Gorham G, Howard K, Balasubramanya B, Coffey P, et al. Barriers and enablers to implementing and using clinical decision support systems for chronic diseases: a qualitative systematic review and meta-aggregation. *Implement Sci Commun* 2022 Jul 28;3(1):81–x.
 42. Chaudoir SR, Dugan AG, Barr CH. Measuring factors affecting implementation of health innovations: a systematic review of structural, organizational, provider, patient, and innovation level measures. *Implementation Science* 2013;8(1):22.
 43. Pratt R, Saman DM, Allen C, Crabtree B, Ohnsorg K, Sperl-Hillen JM, et al. Assessing the implementation of a clinical decision support tool in primary care

- for diabetes prevention: a qualitative interview study using the Consolidated Framework for Implementation Science. *BMC Med Inform Decis Mak* 2022 Jan 15;22(1):15–x.
44. Ethier A, Carrier A, Dubois M. Strategies Used by Home Health Care Professionals Working With Older Adults to Navigate the Institutional Context: An Integrative Review. *Home Health Care Management & Practice* 2023;10848223231183016.
45. Damschroder LJ, Aron DC, Keith RE, Kirsh SR, Alexander JA, Lowery JC. Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. *Implement Sci* 2009 Aug 7;4:50–50.
46. Varsi C, Ekstedt M, Gammon D, Ruland CM. Using the Consolidated Framework for Implementation Research to Identify Barriers and Facilitators for the Implementation of an Internet-Based Patient-Provider Communication Service in Five Settings: A Qualitative Study. *J Med Internet Res* 2015 Nov 18;17(11):e262.
47. Franco LM, Bennett S, Kanfer R. Health sector reform and public sector health worker motivation: a conceptual framework. *Soc Sci Med* 2002;54(8):1255–1266.
48. Hudson JL, Moon Z, Hughes LD, Moss-Morris R. Engagement of stakeholders in the design, evaluation, and implementation of complex interventions. *The handbook of behavior change* 2020:349–360.
49. Ministerie van Volksgezondheid W,en Sport. Integraal Zorgakkoord 2022–2027. 2022.
50. Waltz TJ, Powell BJ, Chinman MJ, Smith JL, Matthieu MM, Proctor EK, et al. Expert recommendations for implementing change (ERIC): protocol for a mixed methods study. *Implementation Science* 2014;9(1):39.

APPENDIX A

INTERVIEW GUIDE

Exploring Barriers and Facilitators for the Potential Implementation of the Decision Tool-Functional Independence in Primary Care

Introduction and explanation

Thank you for wanting to participate in this Q&A today. With this interview, we want to gain insight into promoting and hindering factors for the use of the Decision tool Functional Independence (DST-FI). My name is Esther Molenaar, I am a researcher on the project “Samen sterk voor Fysieke Zelfredzaamheid”. Because the decision tool is still under development, I will show you some images later to explain how the decision tool works and you can ask any questions you may have. You also received information about the decision tool before this interview. We hope you were able to review the information and if you still have questions about it after the explanation, there is still time to answer the questions before we start the interview. The interview takes a maximum of 60 minutes, for research purposes we record the interview with an audio recorder. After analysis and transcription, the data is stored anonymously.

Decision tool Functional Independence (DST-FI)

The decision tool is an instrument to support the care or welfare professional in the decision-making around needed care in Functional Independence. Functional Independence is the ability to function independently of another person in one's own environment. The purpose of the tool is to optimize care around older persons. In doing so, the tool stimulates inter- and multidisciplinary cooperation for the benefit of this target group.

The decision tool works as follows:..... (show images of the decision aid and go through the steps).

After visualizing the use of the decision tool and reading the information, do you still have questions about using the decision aid?

Have all questions been answered?

Interview

The interview will focus on 3 themes* that we have selected based on recent scientific literature:

Characteristics of the Choice Tool

Characteristics of the people who will work with the Choice Aid

The environment in which the Choice Aid will be applied.

If there are no further questions we start the interview.

Start recording:

My name is Esther Molenaar, today's date is....., in front of me is..... Are you clear that you are voluntarily participating in the study and you may stop the interview at any time without giving a reason?

Start with an open-ended question:

This study is about promoting and hindering factors for using this Choice Tool. What do you think are important factors that may play a role in your and/or colleagues' use of the Choice Aid?

Characteristics of the Choice Aid:

How does the decision aid (Physical Self-Efficacy) compare to other similar/similar existing interventions/choice aids in your practice?

How does the decision aid compare to other alternatives that may have been considered in decision-making around this target population or that you are aware of?

Is there another intervention/tool that people prefer to use?

Adaptations:

What kinds of changes or adaptations do you think you need to make to the decision aid so that it will work effectively in your setting?

Who will decide (or what is the process for deciding) whether changes are needed to the decision aid so that it will work well in your setting? Which people are important for this and what are their roles (CFIR 2.0 roles).

Are there things/parts that should not be changed at all?

Design quality & packaging:

How do you feel about how the decision aid is presented?

Is what you need to use the decision aid available? Is this difficult or just easily available? Does this influence you think the use of the decision aid and to what extent?

Costs:

What costs are incurred to implement the intervention do you think?

Characteristics of the people who will work with the Choice Help:

Start with an open question: This research focuses on the commissioning of the Choice Help physical self-sufficiency. How do you see your role/function in relation to the commissioning of the physical self-sufficiency decision aid?

What do you know about the Choice Aid or its use?

Do you think the decision aid will make an effective contribution in your setting?

How do you feel about using the Choice Aid in your setting?

Self-confidence:

How confident are you that you can successfully implement the decision aid?

How confident are you that you can use the decision aid appropriately?

How much confidence do you think your colleagues have in implementing the decision aid?

How much confidence do you think your colleagues have in implementing the decision aid?

How (self)confident(d) do you think your colleagues are in using the decision aid?

Stage of change:

How prepared are you to start using the decision aid?

The environment/setting in which the decision aid is applied:

Start with open question: Can you tell what your work setting looks like/what kind of setting are you working in?

The setting/setting in which the decision aid will be used.

How aware are you and/or your colleagues, of the preferences and needs of people over 65 visiting the practice?

Are there specific actions aimed at identifying the needs of people over 65? Can you give an example of this?

Do you and/or your colleagues see the value of the decision aids for those over 65 that you see in practice?

If, yes: What do you think is the added value to the older person/client?

If no: Why do you think there is no added value?

Could you explain this using a case study of an older person visiting the practice?

To what extent are the needs and preferences of the over-65s, who visit your practice, considered when deciding to implement such innovations?

Can you describe specific examples?

When implemented, will the decision aid be tailored to their needs and preferences?

How well do you think the decision aid will meet the needs of the older persons coming into your practice?

In what ways will the decision aid meet their needs? E.g. improved care delivery, more insight into possible next steps, more insight into future perspective, help with self-management, help with communication with caregivers etc.

Can you give an example of this?

How do you think people over 65 will react to the decision aid?

Why do you think so?

What barriers will these over-65s face to having the associated measurement battery taken?

Why do you think so? Can you explain this with an example?

And what barriers will these over-65s encounter when they want to follow the advice from the decision aid?

Why do you think so? How do you think this could be remedied? How aware are you and/or your colleagues, of the preferences and needs of people 65 and older who visit the practice?

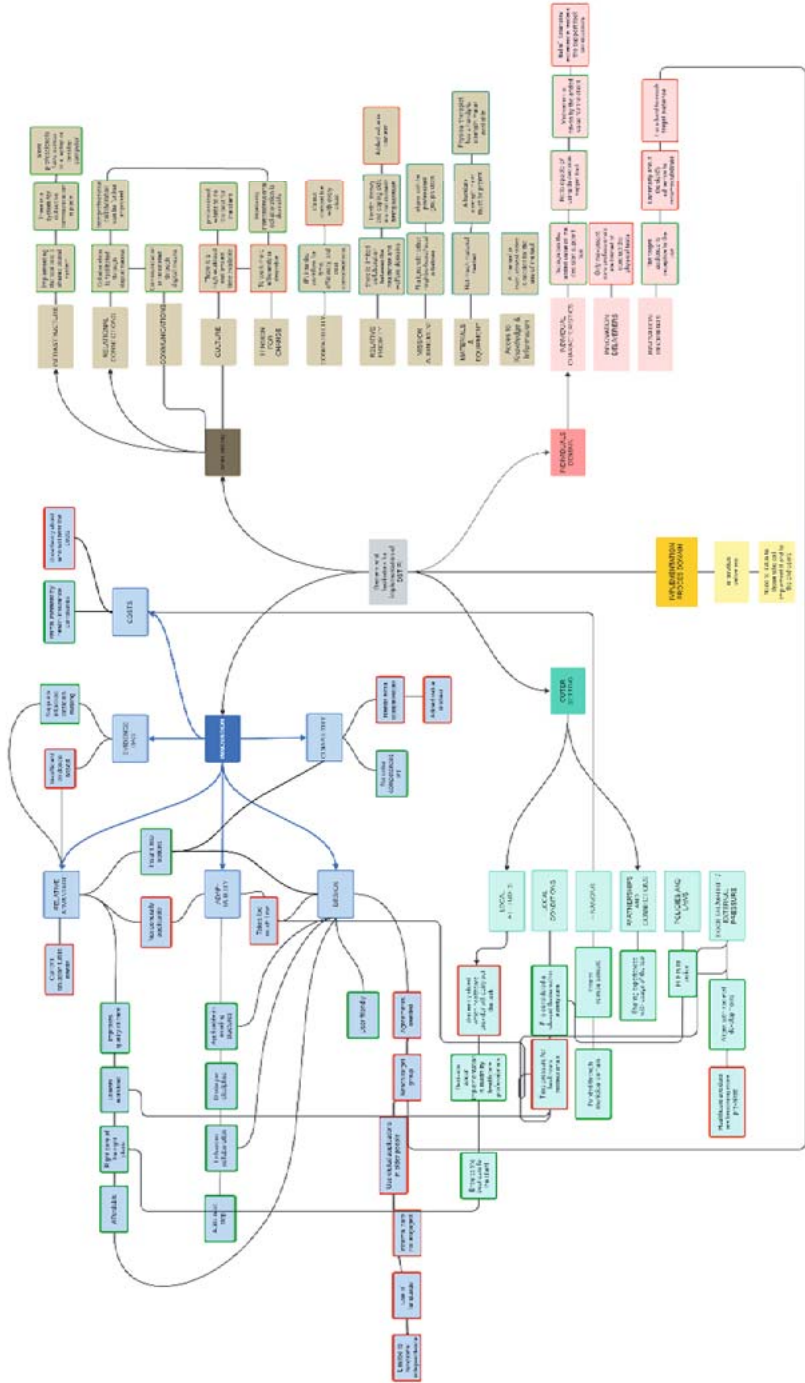
Do you and/or your colleagues see the value of the decision aid for people aged 65 and older that you see in practice?

Wrap-up

After a maximum of 60 minutes, the interview is concluded. The participant is thanked for their valuable contribution to the study and is invited to express interest in receiving the study results. Additionally, they are asked if they are open to participating in a potential follow-up member check.

APPENDIX B.

Full mapping of identified themes across all CFIR domains, including emergent findings beyond the selected domains.



Chapter 8

General Discussion

GENERAL DISCUSSION

Maintaining and enhancing Functional Independence (FI) in older people has become a top priority in many healthcare systems worldwide (1). This growing urgency is driven by demographic ageing and the increasing prevalence of chronic diseases, multimorbidity, and geriatric syndromes such as frailty, all of which contribute to a higher risk of dependency (2,3). In the Dutch context, these challenges are further intensified by a shift towards greater reliance on informal care, while traditional caregiving roles, often fulfilled by women, are increasingly difficult to sustain due to growing female workforce participation (4). However, translating this policy priority into daily clinical practice remains challenging. Healthcare professionals often lack a shared language, timely recognition of declining functioning, and practical tools to systematically assess and support FI. Against this background, this thesis aimed to advance the understanding of FI in older people and to develop tools that help professionals monitor, interpret, and support independent functioning in this population.

This chapter aims to provide a comprehensive perspective on optimizing FI in older adults, with the ultimate ambition of contributing to improved quality of life and more effective healthcare strategies. The discussion is structured around a reflection on the main findings, followed by methodological considerations and implications for practice, education, and future research.

Main findings

A better understanding of Functional Independence (FI) starts with a clear and shared understanding of what FI entails. **Chapter 2** presents a working definition of FI as *physically safe and independent functioning, determined by physical capacity, coping, empowerment, and health literacy*. The results of the cross-sectional study in **Chapter 3** demonstrate that the Core Outcome Set Functional Independence (COSFI) can predict the level of FI with 68% accuracy. Adding the domains of health literacy and coping to physical capacity significantly improved the model, underlining the importance of a multidimensional approach. **Chapter 4** presents a cluster analysis that identified four distinct FI profiles among community-dwelling older people. Each of these subgroups benefits from tailored advice, care, or support to maintain their level of FI. **Chapter 5** assesses the validity and reliability of the DST-FI when used by community-care professionals to provide recommendations for maintaining FI in older people. Results showed high construct and content validity, and moderate interrater reliability. These findings support the DST-FI's potential to assist professionals in preserving FI, while highlighting the need for further optimisation. **Chapter 6** describes the feasibility of implementing the Decision Support Tool for Functional Independence (DST-FI) in clinical practice. Older adults found the tool useful for increasing awareness and supporting decision-making, and would recommend its use. Physical therapists appreciated the concept but reported concerns about time constraints, integration into existing workflows, and interpretation of results. **Chapter 7** explores barriers and facilitators to implementing the DST-FI in primary care, based on insights from a broad group of healthcare professionals and older adults. Key facilitators included the tool's

potential to support informed decision-making and foster interprofessional collaboration. Major barriers included time constraints, unclear ownership, limited applicability for certain groups, and challenges in preventive outreach.

Reflection on the main findings

Based on the main findings presented in this thesis, four overarching themes were identified that form the structure of this discussion. First, the concept of Functional Independence (FI) itself is examined, highlighting its relevance in the context of an ageing population. Second, the multidimensional nature of FI and its implications for professional practice are discussed. Third, the heterogeneity among older persons is addressed, underscoring the importance of personalised and timely care. Fourth, the role of prevention and the challenges it presents are explored. These reflections are followed by methodological considerations and implications for the organisation of primary care and for education.

Functional Independence as a fundament of care for older people

This thesis explored strategies to enhance Functional Independence (FI) among older persons, recognising its value in promoting autonomy, quality of life, and reducing dependency on formal care. Supporting FI can help individuals maintain daily functioning, delay institutionalisation, and reduce pressure on healthcare systems (1,5). The FI definition and accompanying conceptual model developed in this thesis offer a practical and structured foundation for professionals to support older persons through targeted assessments and interventions (6). By offering a shared language and clear framework, the model enables consistent care strategies and supports both preventive and rehabilitative approaches (7,8). The focus on FI also aligns with international trends such as the re-ablement movement and with current Dutch policy that encourages older persons to live independently at home for as long as possible (9).

At the same time, several important considerations must be taken into account. **First**, although the concept of FI is internationally relevant, the interpretation and application of FI, as defined and modelled in this thesis, are rooted in the Dutch context. Cross-cultural research shows that views on independence and caregiving differ: while individualistic societies in northwestern Europe emphasise self-reliance, collectivist cultures tend to value communal caregiving (10,11). This calls for caution when applying these results in other contexts, where societal values and healthcare structures may differ (12-14). **Second**, based on the findings from Chapter 2, the promotion of FI may place increased demands on community-based healthcare services, necessitating a shift towards more neighbourhood-oriented and extramural care. This direction aligns with current Dutch policy, which strongly promotes ageing in place and supporting older persons to live independently at home for as long as possible (12). However, despite this policy emphasis, the current care infrastructure is not yet fully equipped to meet these demands. A more proactive and integrated primary care approach is needed, one that can identify early signs of decline, mitigate health risks, and prevent unsustainable conditions in the home environment (15). **Third**, while the FI

definition and conceptual model introduced in Chapter 2 encompass multiple domains, including coping, empowerment, and health literacy, the operational focus of the COSFI and DST-FI remains primarily on physical functioning. Cognitive decline, although frequently co-occurring and highly relevant to daily independence, is not currently addressed (16,17). This was a deliberate choice to ensure usability and feasibility in daily practice. However, in practice, it remains important to consider cognitive functioning alongside FI, particularly when interpreting results or deciding on interventions. Mild cognitive impairment can significantly influence a person's ability to function independently, even when physical functioning appears intact (18). Therefore, future versions of the tool could benefit from including a brief cognitive screening component. This would enable a more holistic assessment of FI and support better tailoring of care strategies, particularly in cases where cognitive and physical factors interact. Until such integration is realised, professionals interpreting COSFI or DST-FI outcomes should remain alert to possible cognitive problems and, where relevant, complement FI assessment by consulting a specialist in cognitive functioning.

Altogether, the FI definition and conceptual model offer professionals a meaningful foundation to strengthen the independence and quality of life of older persons within a complex and evolving care landscape.

The importance of Interprofessional Collaboration and T-shaped professionals

Findings from Chapters 6 and 7 show that interprofessional collaboration is essential for the effective use of the DST-FI. Professionals indicated that responsibilities are often unclear, communication between sectors is limited, and collaboration does not always happen as intended. At the same time, the DST-FI appears to support collaboration by providing a shared language and structure that professionals can use to coordinate care. In this context, the role of healthcare professionals is evolving. Increasingly, professionals are expected not only to master their own discipline but also to collaborate effectively across domains. One way to support this is through the development of T-shaped skills: professionals who combine deep expertise in one area with a broad understanding of related domains. This skill profile is intended to promote integrated, person-centred care by fostering adaptability and communication across disciplines. Such cross-disciplinary competencies can reduce fragmentation and strengthen collaboration in healthcare settings (19). However, prioritising breadth over depth in educational programmes may come at the expense of specialised expertise (20,21). Finding the right balance between disciplinary depth and cross-domain understanding will therefore be essential. In addition, interprofessional collaboration does not occur automatically and must be actively supported (22). This requires structural conditions such as sufficient time, clear communication channels, and organisational support. Without these, even well-intentioned professionals may struggle to collaborate effectively in daily practice.

This thesis contributes to this discussion by showing how a shared framework, such as the DST-FI, can help bridge professional boundaries. Rather than replacing specialist knowledge or disciplinary

depth, the tool encourages professionals to align their perspectives and combine their expertise with broader, cross-disciplinary understanding. In this way, the DST-FI both requires and reinforces interprofessional collaboration, which is essential for delivering high-quality, integrated care in ageing societies (23).

Balancing Personalised Care and Feasibility

A promising way to balance personalised care with practical delivery lies in the use of care profiles: groupings based on shared characteristics or levels of need (24). In mental healthcare, for example, stepped care models have been used to match treatment intensity to patient profiles, improving both outcomes and resource use (25). Similarly, in geriatric rehabilitation, functional profiles can help guide treatment goals and team coordination (26). These studies illustrate how profile-based care can support responsiveness within a structured framework. When combined with decision-support tools, this approach can facilitate complex decision-making and promote consistency in care delivery (26). While, several studies have noted that such tools may also risk oversimplifying care or reducing professional autonomy when applied too rigidly (27). However, putting personalised care into practice remains difficult, given workforce limitations, scalability issues, and resource constraints (28). In contrast, standardised models offer consistency and cost-effectiveness, but often at the expense of person-centeredness (29). Profile-based care can help reconcile these tensions (30). This thesis contributes to this discussion by developing and evaluating the DST-FI: a decision-support tool that provides tailored recommendations based on four distinct FI profiles (Chapter 4). The DST-FI helps professionals structure their decisions while preserving space for clinical reasoning and individualisation. In Chapter 5, professionals described the tool as a helpful guide, especially for interdisciplinary collaboration and care planning. At the same time, they reported challenges in applying it consistently, particularly when it did not fully align with existing routines or when patient needs fell between profile categories. These findings align with earlier concerns that decision aids must support, rather than replace, professional judgement (31,32). The success of tools like the DST-FI depends on their ability to adapt to real-world contexts, support reflective practice, and remain flexible enough to accommodate individual variation (33,34). In this way, the DST-FI offers a concrete and practice-based contribution to personalised care: it supports profile-based decision-making while respecting the complexity of individual cases. However, its successful integration into routine care still requires deliberate implementation efforts. Generating the knowledge and tools is only the first step; embedding them into daily practice remains a key challenge for the coming years.

Preserving Functional Independence: From Barriers to Opportunities

Although the DST-FI may help tailor treatments to the individual needs of older people, the challenge lies in proactively supporting Functional Independence (FI) over the long term (29,32). Preventive strategies, such as those explored in this thesis, are often considered complex to

implement, especially in healthcare systems traditionally geared towards reactive, curative care models (28,35). Yet this complexity does not diminish the importance of prevention; it reinforces the urgency to redesign care systems that currently prioritise cure over prevention (36). Preserving FI is not only vital for enhancing the quality of life and promoting social participation in older people, but also aligns with broader societal and policy ambitions for healthy ageing (37,38). For example, the Dutch National Prevention Agreement explicitly promotes the integration of preventive approaches within the healthcare system (39). Although implementation faces challenges, such as reaching and motivating the target population, there are clear opportunities to shift the focus (40). Findings from Chapters 6 and 7 show that the DST-FI is considered feasible in practice. While its preventive use remains underutilised, participants pointed to opportunities to enhance its deployment. These include embedding the tool within routine assessments, linking it to existing funding mechanisms for preventive home visits, and using community-based outreach to improve engagement. Moreover, there is growing knowledge about what makes preventive implementation successful: early involvement of stakeholders, alignment with local policy frameworks, and flexible, personalised delivery models (41,42). Thus, while implementation remains complex, the current momentum in national policy and growing attention to healthy ageing provide fertile ground for rebalancing the system. The key lies in translating policy ambition into practical, scalable models that put FI at the centre of care.

Methodological considerations:

The methodology applied in this thesis, which includes a combination of scoping review, instrument validation, cluster analysis, qualitative research, and pilot-feasibility methods, was aligned with the innovative nature of the research questions (43-46). By integrating a variety of approaches, a more comprehensive and multidimensional perspective was achieved, enriching the insights obtained and enhancing the validity of the findings (47). A strength of this thesis is its participatory approach, particularly the focus on co-creation and engagement with relevant stakeholders, such as healthcare professionals and older persons in the different studies (**Chapters 2, 6, and 7**) (48). Nevertheless, the diversity of methods ranging from quantitative analyses to qualitative input from stakeholders, made it challenging to synthesise findings into a single, cohesive interpretation of Functional Independence (49). In addition, the full potential of participatory and inclusive approaches could have been more fully utilised. For example, involving a larger and more diverse group of older persons in co-design sessions during the tool development phase, rather than mainly in later evaluation stages, could have deepened the understanding of user preferences and everyday challenges. Similarly, inviting older persons to participate in early prototyping or decisions around implementation strategies would have allowed their practical insights and perspectives to shape more relevant and context-specific adaptations of the tool (50). Looking forward, incorporating more design-oriented methodologies, such as design thinking or living lab approaches, could offer concrete next steps to improve user-centredness. These approaches support iterative development, stimulate creative problem-solving, and help better align tools like the DST-FI with the daily lives and priorities of older persons (51,52).

The feasibility and implementation phases of this research included smaller sample sizes, which is common in practice-oriented innovation studies that prioritise practical relevance over statistical power (53,54). These small-scale studies provide valuable insights into specific contexts and help to explore feasibility, usability, and real-world applicability (53). However, the limited sample sizes do affect the scalability and generalizability of the findings. For example, the results cannot be readily extrapolated to different care settings, such as acute hospital care or multicultural urban populations, where needs and contexts may differ substantially. Nevertheless, the methodologies chosen still offer a solid foundation for further research. They allow for iterative testing and refinement of the DST-FI in practice, and form the groundwork for future studies with larger, more diverse samples and stronger external validity (55,56).

Implications for research

The findings presented in this thesis underline the need for future research with larger and more diverse samples and the application of implementation science methodologies to strengthen the long-term applicability of the DST-FI in a broader context. In addition to methodological expansion, further steps are needed to evaluate the tool's real-world impact. This includes broader implementation across different care settings and a structured, longitudinal evaluation of its use in daily practice (57). Such an evaluation should examine whether the DST-FI supports interprofessional collaboration and contributes to improved care processes for the older persons it is intended to serve (58). Monitoring the tool's adoption and use over time will help identify what works, what needs adjustment, and how it can be sustainably embedded into routine practice. These insights will be essential to ensure that the DST-FI continues to provide meaningful support, not only for clinical decision-making, but ultimately for maintaining and enhancing Functional Independence among older persons.

Implications for Primary Care

This thesis highlights the importance of maintaining Functional Independence (FI) as a key priority in primary care. To ensure timely and appropriate interventions that prevent functional decline, structural support within the care system is needed (59). Existing proactive primary care programmes, such as “Om U” in the Utrecht region, have demonstrated the value of systematically using routine care data to detect frailty at an early stage in general practice (5). Risk-oriented tools such as the electronic Frailty Index (eFI) play an important role in identifying who may be at risk (60).

The COSFI and DST-FI developed in this thesis offer a complementary perspective: a function-focused and person-centred approach that supports professionals in exploring what older persons can and want to do in daily life (**Chapter 3**).

To further strengthen the role of FI in primary care and ensure sustainable implementation of these tools, three key implications can be identified:

Integrate the COSFI into routine primary care

COSFI should be applied as a standard assessment tool for all older persons in primary care, not just those already flagged as frail. This enables early identification of risks for functional decline and promotes timely, goal-oriented care planning. It also provides a shared framework for professionals to discuss function in a structured and meaningful way.

Embed the DST-FI in primary care workflows

Effective use of the DST-FI requires more than just the availability of the tool. It needs targeted implementation strategies that support professionals in its use, such as training, integration into existing ICT systems, and clear agreements on when and how to use the tool (61). The DST-FI should enhance shared decision-making and team-based intervention planning (**chapter 6 and 7**).

Connect with existing systems for early detection

The COSFI and DST-FI should not replace, but rather complement, existing frailty detection systems (42). For example, COSFI could be applied after a patient has been flagged through automated risk analysis (such as the electronic frailty index (60)) to explore functional goals in more depth. This layered approach can bridge population-level screening and individual-level functional assessment.

To realize these implications, primary care professionals, researchers, policymakers, and health insurers all have to take their roles. Primary care teams need support in implementing the COSFI and DST-FI. Researchers should continue evaluating and refining these tools, and system-level actors should create the conditions to reward proactive, function-oriented care (13,62).

Implications for Education

This thesis highlights the need to integrate Functional Independence (FI) as a core concept in healthcare education, ensuring that future professionals are equipped with the knowledge and skills to assess, prevent, and manage functional decline in older persons. This aligns with existing national visions on healthcare and ageing, such as the Dutch concept of Positive Health, which emphasises people's ability to adapt and self-manage, and the longstanding recommendations of the Health Council of the Netherlands that promote a focus on functioning and participation rather than disease alone (63,64).

To realise this in education, programmes should foster interprofessional learning (IPE), enabling students from various healthcare disciplines to learn with, from, and about each other to improve collaboration and support personalised care. Embedding FI as a shared learning objective supports integrated care delivery and prepares students for the collaborative challenges of future healthcare practice (65,66). Interprofessional education is particularly relevant in countering the limitations of traditional, siloed healthcare training, which may lead to uni-professional identities that hinder effective teamwork (67). Research has shown that students who engage in interprofessional learning develop stronger collaborative skills and a deeper understanding of their own and others'

professional roles (65). Furthermore, IPE contributes to professional identity formation by fostering shared values, communication skills, and teamwork competencies, all of which are essential for supporting Functional Independence in older persons (68).

To align with current trends in education, rich learning environments should be created where students can experience authentic interprofessional collaboration, both in classroom settings and during clinical placements (66). An example of this is the SUMMA programme in Utrecht, where students from medicine and nursing learn to work jointly on real clinical cases (69). Educational frameworks such as De Nieuwe Utrechtse School (DNUS) promote interprofessional, reflective, and personalised learning to prepare students for the complexity of modern healthcare (70). It also promotes co-creation, connection, and responsibility as guiding principles. This vision aligns with broader educational developments at Hogeschool Utrecht (HU), where context-rich, interprofessional learning environments are increasingly integrated into healthcare curricula. These settings offer valuable opportunities for students to develop competencies for personalised, collaborative care. While not yet explicitly focused on Functional Independence (FI), such learning environments offer a promising foundation to further embed FI as a cross-cutting theme in future interprofessional education across vocational and academic levels (71). Inspired by the DNUS vision, collaborations are emerging between UMC Utrecht, HU (applied sciences), and MBO colleges to develop a cross-level approach to health education. Through interprofessional workplace learning and co-creation across university (WO), higher vocational (HBO), and secondary vocational education (MBO), students can jointly develop the competencies needed to support Functional Independence in complex care contexts (70).

This requires a shift towards more integrated and practice-oriented curricula, emphasising active engagement, experiential learning, and interdisciplinary problem-solving (72). Moreover, these initiatives should align with institutional policies that support interprofessional collaboration and lifelong learning. By embedding FI into core curricula and fostering interprofessional education, students will be better prepared to contribute effectively to multidisciplinary teams and address the challenges associated with functional decline in older people. Ultimately, this approach will strengthen both patient care and the ability of healthcare systems to deal with age-related complexity.

Final Conclusions

This thesis contributes to the conceptual development of Functional Independence (FI) by offering an integrated, multidimensional definition that reflects both physical functioning and personal and contextual factors. It underscores the importance of FI in older persons and highlights several directions for future research to enhance its assessment and practical application.

Future studies should explore how this integrated definition can be further refined and applied across diverse healthcare settings, ensuring its relevance for both clinical practice and research.

Although the Core Outcome Set for Functional Independence (COSFI) has been validated, more research is needed to examine its long-term utility and effectiveness in tracking changes in FI over time, particularly in relation to health outcomes.

The Decision Tool for Functional Independence and the associated subgroups identified in this thesis provide a foundation for personalised care. However, further research is required to evaluate its impact on clinical outcomes and to investigate its predictive value in identifying future decline in FI.

Implementing the Decision Support Tool for Functional Independence (DST-FI) into routine care is a critical next step. Future projects should focus on scaling up its use, addressing the practical challenges of integration, and evaluating its effects on clinical workflows and patient outcomes. Assessing the (cost-)effectiveness of training programmes for healthcare professionals and ensuring user-friendly digital interfaces will also be essential for widespread adoption.

REFERENCES

1. Crocker T, Clegg A, Riley R, Lam N, Bajpai R, Jordão M, et al. Community-based complex interventions to sustain independence in older people, stratified by frailty: a protocol for a systematic review and network meta-analysis. *BMJ Open* 2021;11.
2. Barnett K, Mercer SW, Norbury M, Watt G, Wyke S, Guthrie B. Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. *The Lancet* 2012;380(9836):37–43.
3. World HO. World report on ageing and health. Geneva: World Health Organization; 2015.
4. Singleton J. Women Caring for Elderly Family Members: Shaping Non-Traditional Work and Family Initiatives. *Journal of Comparative Family Studies* 2000 /09/01;31(3):367–375.
5. Bleijenberg N, de Jonge A, Brand MP, O'Flynn C, Schuurmans MJ, de Wit NJ. Implementation of a proactive integrated primary care program for frail older people: from science to evidence-based practice. *Tijdschr Gerontol Geriatr* 2016 Dec;47(6):234–248.
6. Molenaar EALM, Barten JA, te Velde S, van der Schoot L, Bleijenberg N, de Wit NJ, et al. Functional Independence in the Community Dwelling Older People: a Scoping Review. *Journal of Population Ageing* 2023;16(1):243–262.
7. McLaney E, Morassaei S, Hughes L, Davies R, Campbell M, Prospero LD. A framework for interprofessional team collaboration in a hospital setting: Advancing team competencies and behaviours. *Healthc Manage Forum* 2022;35(2):112–117.
8. Supper I, Catala O, Lustman M, Chemla C, Bourgueil Y, Letrilliart L. Interprofessional collaboration in primary health care: a review of facilitators and barriers perceived by involved actors. *J Public Health (Oxf)* 2014;37(4):716–727.
9. Guadaña J, Oyeneyin B, Moe CF, Tuntland H. Publication Trends in Reablement - A Scoping Review. *J Multidiscip Healthc* 2023 Jun 13;16:1641–1660.
10. Phelan EA, Anderson LA, LaCroix AZ, Larson EB. Older adults' views of "successful aging" — How do they compare with researchers' definitions? *J Am Geriatr Soc* 2004;52(2):211–216.
11. Hofstede G. *Culture's Consequences: Comparing Values, Behaviors, Institutions, and Organizations Across Nations*. : Sage Publications; 2001.
12. Ministerie van Volksgezondheid W,en Sport. Wonen, Ondersteuning en Zorg voor Ouderen (WOZO): Samen naar een nieuwe generatie ouderenbeleid. 2022.
13. Ministerie van Volksgezondheid W,en Sport. De Juiste Zorg op de Juiste Plek. 2018.
14. Ministerie van Volksgezondheid W,en Sport. Integraal Zorgakkoord (IZA). 2022.
15. Crocker T, Ensor J, Lam N, Jordão M, Bajpai R, Bond M, et al. Community based complex interventions to sustain independence in older people: systematic review and network meta-analysis. *The BMJ* 2024;384.
16. Njegovan V, Man-Son-Hing M, Mitchell S, Molnar F. The hierarchy of functional loss associated with cognitive decline in older persons. *The journals of gerontology Series A, Biological sciences and medical sciences* 2001;56 10.
17. Millán-Calenti J, Tubío J, Pita-Fernández S, Rochette S, Lorenzo T, Maseda A. Cognitive impairment as predictor of functional dependence in an elderly sample. *Arch Gerontol Geriatr* 2012;54 1:197–201.
18. Lindbergh C, Dishman R, Miller L. Functional Disability in Mild Cognitive Impairment: A Systematic Review and Meta-Analysis. *Neuropsychol Rev* 2016;26:129–159.
19. Donofrio N, Spohrer J, Seif Zadeh H. Research-Driven Medical Education and Practice. A case for T-Shaped Professionals. 2010.
20. Vriesman M, Dhuga J, LaLonde L, Orkopoulou E, Lucy C, Teeple T, et al. Clinical Psychologists as T-Shaped Professionals. *Perspect Psychol Sci* 2023;18(5):996–1008.
21. Frenk J, Hunter DJ, Lapp I. A renewed vision for higher education in public health. *Am J Public Health* 2015 Mar;105 Suppl 1(Suppl 1):109.
22. Supper I, Catala O, Lustman M, Chemla C, Bourgueil Y, Letrilliart L. Interprofessional collaboration in primary health care: a review of facilitators and barriers perceived by involved actors. *J Public Health (Oxf)* 2014;37(4):716–727.
23. Rawlinson C, Carron T, Cohidon C, Arditi C, Hong QN, Pluye P, et al. An Overview of Reviews on Interprofessional Collaboration in Primary Care: Barriers and Facilitators. *Int J Integr Care* 2021 Jun 22;21(2):32.
24. Richards DA, Hill JJ, Gilbody S, Coventry PA, Gask L, Kendrick T, et al. Collaborative care and stepped care. *Primary Care Mental Health: Cambridge University Press Cambridge, MA*; 2018.

25. Cross S, Hickie I. Transdiagnostic stepped care in mental health. *Public health research & practice* 2017;27 2.
26. Skoumal M, Lindner-Rabl S, Honegger M, Pertinatsch C, Kadane C, Neubacher B, et al. Goal Setting for Participatory Person-Centered Geriatric Rehabilitation—From Function-Centered Rehabilitation towards Digitally Supported Personalized and Integrated Care for Older People. *Journal of Clinical Medicine* 2024;13.
27. Benetos A, Petrovic M, Strandberg T. Hypertension Management in Older and Frail Older Patients. *Circ Res* 2019;124:1045.
28. Greenhalgh T, Papoutsis C. Spreading and scaling up innovation and improvement. *BMJ* 2019;365:l2068.
29. Kitson A, Marshall A, Bassett K, Zeitz K. What are the core elements of patient-centred care? A narrative review and synthesis of the literature from health policy, medicine and nursing. *J Adv Nurs* 2013;69(1):4–15.
30. JA D. Barten. Personalizing non-surgical care in patients with osteoarthritis of the hip or knee. Utrecht, The Netherlands: Utrecht University; 2018.
31. Elwyn G, Frosch D, Thomson R, Joseph-Williams N, Lloyd A, Kinnersley P, et al. Shared decision making: a model for clinical practice. *J Gen Intern Med* 2012 Oct;27(10):1361–1367.
32. Epstein RM, Street RLJ. The values and value of patient-centered care. *Ann Fam Med* 2011;9(2):100–103.
33. Yardley L, Morrison L, Bradbury K, Muller I. The Person-Based Approach to Intervention Development: Application to Digital Health-Related Behavior Change Interventions. *J Med Internet Res* 2015;17(1):e30.
34. Krebs P, Prochaska JO, Rossi JS. A meta-analysis of computer-tailored interventions for health behavior change. *Prev Med* 2010;51(3-4):214–221.
35. Nilsen P. Making sense of implementation theories, models and frameworks. *Implementation Science* 2015;10(1):53.
36. Hulscher ME, Wensing M, Grol RP, van der Weijden T, van Weel C. Interventions to improve the delivery of preventive services in primary care. *Am J Public Health* 1999;89(5):737–746.
37. Puts MTE, Toubasi S, Atkinson E, Ayala AP, Andrew M, Ashe MC, et al. Interventions to prevent or reduce the level of frailty in community-dwelling older adults: a protocol for a scoping review of the literature and international policies. *BMJ Open* 2016 Mar 2;6(3):e010959–010959.
38. Pillay J, Gaudet LA, Saba S, Vandermeer B, Ashiq AR, Wingert A, et al. Falls prevention interventions for community-dwelling older adults: systematic review and meta-analysis of benefits, harms, and patient values and preferences. *Syst Rev* 2024 Nov 26;13(1):289–3.
39. Ministerie van Volksgezondheid WeS. National Prevention Agreement. 2018; .
40. Rogers HL, Pablo Hernando S, Núñez-Fernández S, Sanchez A, Martos C, Moreno M, et al. Barriers and facilitators in the implementation of an evidence-based health promotion intervention in a primary care setting: a qualitative study. *J Health Organ Manag* 2021 Sep 2;ahead-of-print(ahead-of-print):349–367.
41. Waltz TJ, Powell BJ, Chinman MJ, Smith JL, Matthieu MM, Proctor EK, et al. Expert recommendations for implementing change (ERIC): protocol for a mixed methods study. *Implementation Science* 2014;9(1):39.
42. World HO. Decade of Healthy Ageing: Plan of Action 2021–2030. 2020.
43. Peters MDJ, Marnie C, Colquhoun H, Garritty CM, Hempel S, Horsley T, et al. Scoping reviews: reinforcing and advancing the methodology and application. *Systematic Reviews* 2021;10(1):263.
44. Reams P, Twale D. The promise of mixed methods: Discovering conflicting realities in the data. *International Journal of Research & Method in Education* 2008;31:133–142.
45. Green CA, Duan N, Gibbons RD, Hoagwood KE, Palinkas LA, Wisdom JP. Approaches to Mixed Methods Dissemination and Implementation Research: Methods, Strengths, Caveats, and Opportunities. *Adm Policy Ment Health* 2015 Sep;42(5):508–523.
46. In J. Introduction of a pilot study. *Korean J Anesthesiol* 2017 Dec;70(6):601–605.
47. Fetters MD, Curry LA, Creswell JW. Achieving integration in mixed methods designs—principles and practices. *Health Serv Res* 2013;48(6):2134–2156.
48. Cornwall A, Jewkes R. What is participatory research? *Soc Sci Med* 1995;41(12):1667–1676.
49. Teddlie C, Tashakkori A. Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences. : Sage; 2009.
50. Cargo M, Mercer SL. The value and challenges of participatory research: strengthening its practice.

- Annu Rev Public Health 2008;29:325–350.
51. Brown T. Design thinking. *Harv Bus Rev* 2008;86(6):84.
52. Brown T, Wyatt J. Design thinking for social innovation. *Stanford Social Innovation Review* 2010;8(1):30–35.
53. Miller CJ, Smith SN, Pugatch M. Experimental and quasi-experimental designs in implementation research. *Psychiatry Res* 2020 Jan;283:112452.
54. Craig P, Dieppe P, Macintyre S, Michie S, Nazareth I, Petticrew M. Developing and evaluating complex interventions: the new Medical Research Council guidance. *BMJ* 2008;337:a1655.
55. Creswell JW. Research design: Qualitative, quantitative, and mixed methods approaches. Thousand Oaks, CA: SAGE Publications; 2013.
56. Polit DF, Beck CT. Generalization in quantitative and qualitative research: Myths and strategies. *Int J Nurs Stud* 2010;47(11):1451–1458.
57. Brugman IM, Visser A, Maaskant JM, Geerlings SE, Eskes AM. The Evaluation of an Interprofessional QI Program: A Qualitative Study. *Int J Environ Res Public Health* 2022 Aug 15;19(16):10087. doi: 10.3390/ijerph191610087.
58. Smit LC, Dikken J, Moolenaar NM, Schuurmans MJ, de Wit NJ, Bleijenberg N. Implementation of an interprofessional collaboration in practice program: a feasibility study using social network analysis. *Pilot Feasibility Stud* 2021 Jan 6;7(1):7–3.
59. Zimlichman E, Nicklin W, Aggarwal R, Bates DW. Health Care 2030: The Coming Transformation. *Catalyst non-issue content* 2021;2(2).
60. Clegg A, Bates C, Young J, Ryan R, Nichols L, Teale EA. Development and validation of an electronic frailty index using routine primary care electronic health record data. *Age Ageing* 2016;45(3):353–360.
61. Proctor EK, Powell BJ, McMillen JC. Implementation strategies: recommendations for specifying and reporting. *Implement Sci* 2013 Dec 1;8:139–139.
62. Ministerie van Volksgezondheid W,en Sport. Visie eerstelijnszorg 2030. 2024.
63. Huber M, Jung HP, van den Brekel-Dijkstra K. Positive Health in practice. In: Huber M, Jung HP, van den Brekel-Dijkstra K, editors. *Handbook Positive Health in Primary Care: The Dutch Example* Houten: Bohn Stafleu van Loghum; 2022. p. 133–178.
64. Gezondheidsraad. Zorg voor een vitale oudere. 2020.
65. Reeves S, Fletcher S, Barr H, Birch I, Boet S, Davies N, et al. A BEME systematic review of the effects of interprofessional education: BEME Guide No. 39. *Med Teach* 2016 Jul;38(7):656–668.
66. Barr H. Toward a theoretical framework for interprofessional education. *J Interprof Care* 2013 Jan;27(1):4–9.
67. Reeves S. The rise and rise of interprofessional competence. *Journal of Interprofessional Care* 2012;26(4):253–255.
68. Khalili H, Orchard C, Laschinger HKS, Farah R. An interprofessional socialization framework for developing an interprofessional identity among health professions students. *J Interprof Care* 2013 Nov;27(6):448–453.
69. Utrecht U. SUMMA: Selective Utrecht Medical Master. 2023.
70. van Rooijen A. Opleiden voor zorg en gezondheid in 2030. *Tijdschrift voor Gezondheidswetenschappen* 2021;99(3):26–30.
71. Utrecht U. De Nieuwe Utrechtse School: Onderwijsstrategie UMC Utrecht. 2022.
72. Thistlethwaite J. Interprofessional education: a review of context, learning and the research agenda. *Med Educ* 2012 Jan;46(1):58–70.

Chapter 9

Summary

Nederlandse Samenvatting

Authors' Contributions

PhD Portfolio

About the Author

Dankwoord & Acknowledgements

SUMMARY

Staying Functionally Independent

Understanding and Supporting Functional Independence in Older People

As population ageing accelerates worldwide, maintaining and promoting Functional Independence (FI) in older people has become a central priority for healthcare systems. In the Netherlands, recent policy programmes, including the Integrated Care Agreement (IZA, Integraal Zorgakkoord), reflect a strategic shift towards enabling older people to live independently at home for as long as possible. However, translating this ambition into daily practice remains challenging. Professionals often lack a shared language and practical tools to assess and support older people's level of FI in a timely and person-centred manner.

The primary objective of this thesis is to improve the understanding of Functional Independence in older people and to develop tools that support healthcare professionals in optimising and maintaining someone's level of FI. To achieve this, the thesis includes conceptual development, empirical validation, cluster analysis, tool development, and implementation research. The broader objective is to contribute to a shift towards proactive, integrated, and appropriate care that aligns with the needs and preferences of older people.

Chapter 2 presents a scoping review and expert consultation addressing the conceptual gap surrounding FI. Despite its frequent use, there was no consensus on a definition. This chapter introduces a working definition of FI as functioning physically safe and independently from others, within one's personal context. It identifies four interrelated domains that shape FI: physical capacity, coping, empowerment, and health literacy. These elements are visualised in a model designed to foster a shared understanding of FI among professionals and to facilitate interdisciplinary dialogue.

After exploring the conceptual model of FI, **Chapter 3** focuses on operationalising FI into measurable units. To that end, the Core Outcome Set for Functional Independence (COSFI) was developed and validated. This outcome set supports consistent, multidimensional assessment across disciplines, thereby addressing the limitations of existing screening methods. COSFI offers a structured, person-centred alternative to traditional frailty screens. Psychometric analysis shows that COSFI can predict the level of FI with 68% accuracy. Notably, including coping and health literacy significantly improves its predictive power beyond the traditional view on physical capacity alone.

Building on the operationalisation of FI in Chapter 3, **Chapter 4** addresses the heterogeneity of older people's status of FI by identifying distinct FI profiles using cluster analysis. The four profiles identified reflect meaningful variation in physical, behavioural, and contextual characteristics, offering a nuanced view of the multidimensional nature of FI. The four profiles are as follows: (1) *Performers – Well-informed*, who are physically strong, educated, and independent, yet tend to use a limited coping style; (2) *Performers – Achievers*, who are also physically strong but have lower coping flexibility and health literacy; (3) *Reliant – Good Copers*, who experience some physical limitations

but compensate with adequate coping strategies and support; and (4) *Reliant – Receivers*, who face physical limitations as well as insufficient coping and low health literacy, and are more dependent on professional help.

Building on the profiles identified in Chapter 4, the Decision Support Tool for Functional Independence (DST-FI) was introduced. The DST-FI is explicitly designed to support, not replace, professional judgement and to allow for person-centred decisions based on individual preferences, goals, and context. The DST-FI guides professionals through three steps: (I) measuring FI using the COSFI, (II) allocating the person to one of the four FI profiles, and (III) generating person-centred care recommendations. **Chapter 5** describes the development process and the initial psychometric evaluation of the tool. Results show acceptable reliability and clinical validity, with professionals confirming the relevance and applicability of most recommendations. By linking measurement to meaningful profiles and actionable suggestions, the DST-FI provides structured support for delivering person-centred care in daily practice.

Chapter 6 examines the feasibility and perceived value of the DST-FI in practice, based on interviews and observations among older people and healthcare professionals in primary care. Older people experienced the tool as relevant and empowering, particularly in helping them recognise early signs of decline. Professionals appreciated the structured guidance and shared language the tool offered in interprofessional collaboration. At the same time, they identified barriers such as time constraints, lack of ownership, and uncertainty about the tool's preventive use in people not yet receiving care.

Building on the development and evaluation of the DST-FI in earlier chapters, **Chapter 7** explores the broader context of its implementation in primary care. Using qualitative methods guided by the Consolidated Framework for Implementation Research (CFIR), this chapter presents findings from interviews with healthcare professionals and focus groups with older adults. Thematic analysis revealed several key facilitators, including alignment with existing care goals, potential to enhance interprofessional collaboration, and resonance with current policy priorities around ageing and prevention (e.g. prevention, ageing in place). At the same time, the study identified four major barriers: limited applicability in certain contexts, time constraints, ambiguous ownership among stakeholders, and challenges in reaching older people preventively. These findings highlight the complexity of implementation and underscore the need for tailored, person-centred strategies that take into account the specific context of care.

Chapter 8 discusses the integrated findings from Chapter 2 to 7 in light of broader debates on ageing, prevention, interprofessional collaboration, and healthcare transformation. Four central reflections are offered: (1) the conceptual relevance of FI as an ideal guiding proactive and person-centred care; (2) the need to balance individualised care goals with the practical realities of implementation in routine settings; (3) the importance of T-shaped professional roles and interprofessional education; and (4) the opportunity, and challenge, of embedding FI within a wider preventive care agenda. Together, these reflections underscore the need for structural support to embed FI into policy,

education, and daily practice, and to enable professionals to work collaboratively across disciplines to promote healthy ageing.

This thesis improves the understanding of Functional Independence in older persons and develops tools to support healthcare professionals in optimising and maintaining someone's level of FI.

NEDERLANDSE SAMENVATTING

Zelfstanding blijven functioneren

Inzicht in en ondersteuning van fysieke zelfredzaamheid bij oudere personen

Door de wereldwijde vergrijzing is het behoud van Fysieke Zelfredzaamheid (FZ) bij oudere personen een steeds belangrijker thema in de gezondheidszorg. Dit thema krijgt onder andere vorm in beleidsprogramma's zoals het Integraal ZorgAkkoord (IZA), waarin gestreefd wordt naar het zo lang mogelijk zelfstandig thuis kunnen blijven wonen door oudere personen. In de praktijk blijkt het echter lastig om deze ambitie te realiseren. Zorgprofessionals beschikken vaak niet over een gedeeld begrippenkader of praktische hulpmiddelen om FZ tijdig en persoonsgericht te beoordelen en te ondersteunen.

Het primaire doel van dit proefschrift is om FZ bij oudere personen beter te begrijpen en meetbaar te maken, en om instrumenten te ontwikkelen en te implementeren die zorgprofessionals ondersteunen bij het optimaliseren en behouden van FZ. Het bredere doel is om zo bij te dragen aan een verschuiving richting proactieve, geïntegreerde en passende zorg die aansluit bij de voorkeuren en behoeften van oudere personen.

In **hoofdstuk 2** onderzoeken we de conceptuele basis voor FZ. Dit hoofdstuk beschrijft een literatuuronderzoek en expertconsultatie waarmee een werkdefinitie van FZ is opgesteld. FZ wordt gedefinieerd als *'fysiek veilig en zelfstandig functioneren, onafhankelijk van andere personen, binnen de eigen context'*. De vier domeinen die FZ beïnvloeden zijn: fysieke capaciteit, coping, empowerment en gezondheidsvaardigheden. De definitie en vier onderliggende domeinen zijn verwerkt in een visueel model dat professionals ondersteunt bij het ontwikkelen van een gedeeld begrip van FZ en interdisciplinaire samenwerking bevordert.

Na het ontwikkelen van dit conceptuele model richt **hoofdstuk 3** zich op het operationaliseren van FZ. Hiervoor werd de *Core Outcome Set for Functional Independence (COSFI)* ontwikkeld en gevalideerd. Deze meetset ondersteunt een consistente en multidimensionale beoordeling van FZ bij thuiswonende ouderen, over beroepsgroepen heen. De COSFI biedt een gestructureerd, persoonsgericht alternatief voor bestaande meetinstrumenten die zich richten op zelfstandig functioneren en zich vaak beperken tot enkel de fysieke capaciteit. Psychometrische analyse toont aan dat de COSFI het niveau van FZ met 68% nauwkeurigheid voorspelt. Het toevoegen van coping en gezondheidsvaardigheden aan fysieke capaciteit verbetert de voorspellende waarde van het meetinstrument aanzienlijk.

Op basis van de meting van FZ met de COSFI, onderzoekt **hoofdstuk 4** de variatie in het niveau van FZ binnen een populatie oudere personen. Via een clusteranalyse werden vier onderscheidende profielen van FZ geïdentificeerd. De vier profielen zijn: (1) *Performers – Well-informed* (fysiek sterk, goed geïnformeerd en zelfstandig, met beperkte copingstijl), (2) *Performers – Achievers* (fysiek sterk, maar met lage coping en gezondheidsvaardigheden), (3) *Reliant – Good Copers* (lichamelijk beperkt,

maar met voldoende coping en ondersteuning), en (4) *Reliant – Receivers* (lichamelijk beperkt, met lage scores op zowel coping als gezondheidsvaardigheden, met meer zorgafhankelijkheid).

Gebaseerd op deze profielen is een praktisch hulpmiddel ontwikkeld voor de zorgpraktijk: de Decision Support Tool for Functional Independence (DST-FI). Deze tool begeleidt professionals in drie stappen naar het geven van persoonsgerichte adviezen aan ouderen om fysiek zelfredzaam te blijven: (1) het meten van FZ met de COSFI, (2) het toewijzen van de persoon aan één van de vier FZ-profielen, en (3) het genereren van persoonsgerichte zorgaanbevelingen. De tool is bedoeld ter ondersteuning van klinisch redeneren en gezamenlijke besluitvorming, niet als vervanging daarvan.

Hoofdstuk 5 beschrijft het ontwikkelproces en de eerste psychometrische evaluatie. De resultaten tonen aan dat de aanbevelingen relevant en toepasbaar zijn voor de meeste zorgprofessionals.

Na de ontwikkeling van de DST-FI onderzoekt **hoofdstuk 6** hoe de tool wordt ervaren in de dagelijkse praktijk. Op basis van interviews en observaties bij oudere personen en zorgprofessionals in de eerstelijnszorg blijkt dat de tool relevant en ondersteunend wordt gevonden. Oudere personen gaven aan dat de tool hielp bij het herkennen van vroege signalen van achteruitgang. Professionals waardeerden de gestructureerde aanpak en het gedeelde begrippenkader in interprofessionele samenwerking. Tegelijkertijd werden belemmeringen voor het gebruik van de tool in de praktijk genoemd, zoals tijdsdruk, onduidelijk eigenaarschap, en onzekerheid over het gebruik van de tool bij mensen die nog geen formele zorg ontvangen.

Om inzicht te krijgen in het bredere implementatieproces van de tool, verkent **hoofdstuk 7** de voorwaarden en belemmeringen voor het toepassen van de DST-FI in de eerstelijnszorg. Op basis van kwalitatieve analyse, geïnformeerd door het *Consolidated Framework for Implementation Research (CFIR)*, zijn inzichten verzameld uit interviews met zorgprofessionals en focusgroepen met oudere personen. Bevorderende factoren zijn onder meer de aansluiting bij bestaande zorgdoelen, kansen voor interprofessionele samenwerking en herkenning binnen beleidsprioriteiten. Tegelijkertijd blijven vier structurele belemmeringen bestaan: beperkte toepasbaarheid in sommige contexten, tijdsdruk, onduidelijk eigenaarschap en moeite om preventief in contact te komen met oudere personen. De bevindingen onderstrepen de noodzaak van persoonsgerichte en contextspecifieke implementatiestrategieën.

Tot slot worden in **hoofdstuk 8** de bevindingen uit de voorgaande hoofdstukken geïntegreerd en geplaatst binnen bredere discussies over preventie, ouderenzorg, interprofessionele samenwerking en zorgtransformatie. Vier centrale reflecties worden besproken: (1) de waarde van FZ als leidend concept in proactieve en persoonsgerichte zorg, (2) de balans tussen individuele zorgdoelen en de uitvoerbaarheid in de praktijk, (3) het belang van T-shaped professionals en interprofessioneel onderwijs, en (4) de kansen én uitdagingen om FZ structureel te verankeren binnen een preventieve zorgagenda. Deze reflecties benadrukken de noodzaak om FZ stevig in te bedden in beleid, onderwijs en praktijk, en om samenwerking tussen disciplines te stimuleren ter bevordering van gezond ouder worden.

Dit proefschrift draagt bij aan het beter begrijpen, meten en ondersteunen van fysieke zelfredzaamheid bij oudere personen, en biedt zorgprofessionals handvatten om met een gedeeld begrippenkader, een gevalideerd meetinstrument en een beslisondersteuningstool tijdig en persoonsgericht te handelen.

AUTHOR'S CONTRIBUTIONS

Chapter 2: Functional Independence in the Community Dwelling Older People: a Scoping Review	
Study concept and design	EM, D-JB, NB, NW, CV
Data Collection	EM, D-JB, LS
Data analysis and interpretation	EM, D-JB, NB, NW, CV
Draft of manuscript	EM, SV
Manuscript editing and review	EM, SV, D-JB, NB, NW, CV
Chapter 3: Discriminative validity of the Core outcome set functional independence in a population of older adults	
Study concept and design	YD, EM, DJ-B, CV
Data Collection	YD, EM, D-JB
Data analysis and interpretation	YD, D-JB, EM
Draft of manuscript	YD, D-JB, EM
Manuscript editing and review	YD, D-JB, EM, CV
Chapter 4: Cluster analysis of functional independence in community-dwelling older people	
Study concept and design	EM, DJ-B, AH, NB, NW, CV
Data Collection	EM, YD
Data analysis and interpretation	EM, D-JB, CV
Draft of manuscript	EM, DJ-B
Manuscript editing and review	EM, DJ-B, NB, NW, CV
Chapter 5: Psychometric evaluation of the Decision Support Tool for Functional Independence in community-dwelling older people	
Study concept and design	SB, DJ-B, EM, NB, NW, CV
Data Collection	SB, EM
Data analysis and interpretation	SB, D-JB, NB, NW, CV
Draft of manuscript	SB, DJ-B
Manuscript editing and review	SB, DJ-B, EM, NB, NW, CV
Chapter 6: Title: Exploring Feasibility and Acceptance of the Functional Independence Decision Tool Among Physical Therapists and Older Persons	
Study concept and design	EM, DJ-B, NB, NW, CV
Data Collection	EM
Data analysis and interpretation	EM, DJ-B, NB, NW, CV
Draft of manuscript	EM, DJ-B
Manuscript editing and review	EM, DJ-B, NB, NW, CV

Chapter 7: Exploring Barriers and Facilitators for the Potential Implementation of the Decision Tool-Functional Independence in Primary Care

Study concept and design	EM, DJ-B, NB, NW, CV
Data Collection	EM
Data analysis and interpretation	EM, DJ-B, NB, NW, CV
Draft of manuscript	EM, DJ-B
Manuscript editing and review	EM, DJ-B, NB, NW, CV

EM: Esther Molenaar, D-JB: Di-Janne Barten, NB: Nienke Bleijenberg, LS: Liedeke van Schoot, SV: Saskia te Velde, YD: Yvonne Dockx, AH: Anne de Hoop, SB: Sander van Bijsterveld, NW: Niek de Wit, CV: Cindy Veenhof

PHD PORTFOLIO

Name of PhD student: E.A.L.M Molenaar

PhD period: 01-01-2018 to 01-07-2025

Name of PhD Supervisors: Prof.dr. C. (Cindy) Veenhof
Prof.dr. N.J. (Niek) de Wit
Dr. N. (Nienke) Bleijenberg
Dr. J.A. (Di-Janne) Barten

PhD training activity	Year	Workload (ECTS)
Courses		
Introduction course PhD program Clinical and Experimental Neuroscience	2017	0.5
Academic Writing in English	2017	3
Basic course on Regulation and Organization for Clinical Investigators (BROK)	2018	1.5
Basic Teaching Qualification – Delivery (BOU)	2019	3
Participatory Learning & Action (PLA) Techniques	2019	1
Summer school		2
Workshops: Tutoring master students		
Communicating your science		
Time management		
Lectures BCRM summer school 2019		
Academic writing for publication	2019	0.5
Qualitative Research Course	2019	0.5
The Art of Presenting Science	2021	2.0
Workshop poster making		0.5
Designing for Implementation	2021	1.0
Dutch University Teaching Qualification – Basic Examination Qualification (BKE)	2025	3
		18.5
National and international conference contributions		
Dag van de Fysiotherapeut (Den Bosch 8 Dec) – 2 posters	2018	0.3
World Physiotherapy Congress (Geneva 10-13 May) – Platform session	2019	0.9
NVFG Congres (Amersfoort, maart) – Keynote Fysieke Zelfredzaamheid	2021	0.3
IBS Congres (Utrecht, juni) – Presentatie Fysieke Zelfredzaamheid	2021	0.15
World Physiotherapy Congress (Dubai 2-4 June) – e-poster presentation	2023	0.9
		2.55

Teaching and Supervision

Curriculum developer – Bachelor of Physiotherapy, HU University of Applied Sciences Utrecht	2018
Module: Beweegzorg in de wijk	
Lecturer – Master's Programme in Geriatric Physiotherapy, HU University of Applied Sciences Utrecht	2017-2018
Course: Functional Independence in Older Persons (Fysieke Zelfredzaamheid)	
Supervisor for students in physiotherapy and related health disciplines	2018-2019
- Supervised a bachelor student (Physiotherapy/Exercise Therapy) on the graduation project: "Functional Independence in Older People" - Supervised the following individual research or graduation projects: 2 Bachelor students in Physiotherapy 1 Bachelor student in Optometry 1 Master student in Human Movement Sciences, Vrije Universiteit Amsterdam 1 Bachelor student in Physiotherapy Science, Utrecht University 2 Master students in Geriatric Physiotherapy 1 Master student in Psychosomatic Physiotherapy	
Workshop series – Functional Independence in Older People Esther Molenaar & Di-Janne Barten	2019-2020
3 workshops delivered during the thematic week Community-Based Physiotherapy (Bachelor of Physiotherapy, HU University of Applied Sciences Utrecht)	
Curriculum developer – Community-Based Physiotherapy (Bachelor of Physiotherapy, HU University of Applied Sciences Utrecht)	2019-2020
Developed the thematic week and project "Samen Sterk voor Fysieke Zelfredzaamheid" as part of the course Beweegzorg in de wijk	
Lecturer – Bachelor of Physiotherapy and Exercise Therapy, HU University of Applied Sciences Utrecht	2019-2020
Block C and D – Project module within Community-Based Physiotherapy (Beweegzorg in de wijk)	
Lecturer – Bachelor of Physiotherapy and Exercise Therapy, HU University of Applied Sciences Utrecht	2020-2021
Project-based education, Community-Based Physiotherapy (Beweegzorg in de wijk) Period C/D	
Guest lecturer – Associate Degree in Health & Social Work, HU University of Applied Sciences Utrecht	2021
Lecture: Project on Functional Independence	
Lecturer – Blended Intensive Programme (BIP) on Global Health International, interdisciplinary programme for students from various European universities (Lisbon, Portugal)	2024
Supervisor – HBO-ICT internship, HU University of Applied Sciences Utrecht Student project: Orientation internship (meeloopstage) within the project Samen Sterk voor Fysieke Zelfredzaamheid	2023-2024
Curriculum developer – Minor Lifestyle Coaching, HU University of Applied Sciences Utrecht	2024
Improved and redesigned lessons within the innovation project of the minor	

Lecturer – Blended Intensive Programme (BIP) on Global Health
 International, interdisciplinary programme for students from various European
 universities (Graz, Austria) 2025

Knowledge Dissemination

Podcast guest – “Functional Independence for Everyone?” 2021
 Interview in *PhysioGlobal Podcast*, Episode 4, published 18 March 2021
[https://www.physioglobal.nl/podcast/episode/a6613fd0/fysieke-zelfredzaam-](https://www.physioglobal.nl/podcast/episode/a6613fd0/fysieke-zelfredzaamheid-voor-iedereen)
[heid-voor-iedereen](https://www.physioglobal.nl/podcast/episode/a6613fd0/fysieke-zelfredzaamheid-voor-iedereen)

Webinar – “Samen sterk voor fysieke zelfredzaamheid” 2023
 Hosted by *PhysioGlobal*, June 2023

Professional Activities

Member – WCF (Wetenschappers Collectief Fysiotherapie) 2021-ongoing

Chair – Geriatrics Expert Group, HU University of Applied Sciences Utrecht 2022-ongoing

¹ ECTS = 28 hours, based on the European Credit Transfer System

LIST OF PUBLICATIONS

International peer-reviewed publications included in this thesis

1. **Molenaar, E.A.L.M., Barten, J.A., Bleijenberg, N., te Velde, S., van der Schoot, L., de Wit, N.J., Veenhof, C.**
Feasibility of the Decision Support Tool for Functional Independence in daily health care practice to support functional independence in community-dwelling older persons. Manuscript submitted for publication.
2. **Molenaar, E.A.L.M.,** Barten, D.J.J.A., Bleijenberg, N., de Wit, N.J., Veenhof, C.
Exploring barriers and facilitators for the potential implementation of the Decision Tool – Functional Independence in primary care. Preprint available at Research Square.
<https://doi.org/10.21203/rs.3.rs-5331984/v1>
3. **Molenaar, E.A.L.M.,** Barten, D.J.J.A., Bleijenberg, N., te Velde, S., van der Schoot, L., de Wit, N.J., Veenhof, C.
Functional Independence in the Community Dwelling Older People: a Scoping Review. *Journal of Population Ageing*, 16(1): 243–262 (2023).
DOI: 10.1007/s12062-020-09315-1
4. **Molenaar, E.A.L.M.,** Barten, D.J., de Hoop, A.M., et al.
Cluster analysis of functional independence in community-dwelling older people. *BMC Geriatrics*, 22, 996 (2022).
<https://doi.org/10.1186/s12877-022-03684-2>
5. van Bijsterveld, S.C., Barten, J.A., **Molenaar, E.A.L.M.,** Bleijenberg, N., de Wit, N.J., Veenhof, C.
Psychometric evaluation of the Decision Support Tool for Functional Independence in community-dwelling older people. *Journal of Population Ageing*, 16, 875–897 (2023).
<https://doi.org/10.1007/s12062-022-09361-x>
6. Dockx, Y.J.C., **Molenaar, E.A.L.M.,** Barten, D.J.A., Veenhof, C.
Discriminative validity of the Core Outcome Set Functional Independence in a population of older adults. *BMC Geriatrics*, 20, 309 (2020).
<https://doi.org/10.1186/s12877-020-01705-6>

International publications outside this thesis

7. Strouwen, C., **Molenaar, E.A.L.M.,** et al.
Protocol for a randomized comparison of integrated versus consecutive dual task practice in Parkinson's disease: the DUALITY trial. *BMC Neurology*, 14, 61 (2014).
<https://doi.org/10.1186/1471-2377-14-61>
8. Strouwen, C., **Molenaar, E.A.L.M.,** Münsks, L., Keus, S.H.J., Bloem, B.R., Rochester, L., Nieuwboer, A.
Dual tasking in Parkinson's disease: should we train hazardous behavior? *Expert Review of Neurotherapeutics*, 15(9), 1031–1039 (2015).
<https://doi.org/10.1586/14737175.2015.1067603>
9. Strouwen, C., **Molenaar, E.A.L.M.,** Keus, S.H.J., Münsks, L., Heremans, E., Vandenbergh, W., Bloem, B.R., Nieuwboer, A.
Are factors related to dual-task performance in people with Parkinson's disease dependent on the type of dual task? *Parkinsonism & Related Disorders*, 22, 131–137 (2016).
<https://doi.org/10.1016/j.parkreldis.2015.11.015>
10. Strouwen, C., **Molenaar, E.A.L.M.,** Keus, S.H.J., Münsks, L., Heremans, E., Vandenbergh, W., Bloem, B.R., Nieuwboer, A.
Test-retest reliability of dual-task outcome measures in people with Parkinson's disease. *Physical Therapy*, 96(8), 1276–1286 (2016).
<https://doi.org/10.2522/ptj.20150171>
11. Strouwen, C., **Molenaar, E.A.L.M.,** Keus, S.H.J., Münsks, L., Heremans, E., Vandenbergh, W., Bloem, B.R., Nieuwboer, A.
Training dual tasks together or apart in Parkinson's disease: results from the DUALITY trial. *Movement Disorders*, 32(8), 1201–1210 (2017).
<https://doi.org/10.1002/mds.27092>

Dutch Publications

1. Lamoen, W., **Molenaar, E.A.L.M.** (2024). Optimaliseren van de valrisico-beoordeling bij ouderen met dementie op psycho-geriatrische afdelingen. *Nederlands Tijdschrift voor Geriatriefysiotherapie*, 37(1), 10–15.
2. Dudink, A., **Molenaar, E.A.L.M.** (2021). Romptesten geven een goede indicatie voor fysiek functioneren bij ouderen. *Nederlands Tijdschrift voor Geriatriefysiotherapie*, 34(3), 22–27.
3. Bruin, N., Onrust-Langen, S., **Molenaar, E.A.L.M.** (2018). Valrisico screening door de praktijkondersteuner. *de POH*, 11(3), 14–18.
4. Zwaan, I., Weterings-van der Veer, G., **Molenaar, E.A.L.M.** (2016). Betrouwbaarheid van de Berg Balance Scale bij dementie: een systematische review. *Nederlands Tijdschrift voor Geriatriefysiotherapie*, 29(4), 30–35.
5. De Kinderen, I., Wienk, K., **Molenaar, E.A.L.M.** (2025). De acceptatie van de Keuzehulp Fysieke Zelfredzaamheid (KFZ) en opvolging van adviezen bij thuiswonende 65-plussers. *Nederlands Tijdschrift voor Geriatriefysiotherapie*, 39(2).

ABOUT THE AUTHOR

Esther Molenaar was born on the 8th of July 1985 in Prinsenbeek, the Netherlands. After graduating with honours from secondary school (Mencia de Mendoza Lyceum in Breda), she studied Physiotherapy at Avans University of Applied Sciences. During her final year, she developed a strong research interest, which led her to start the pre-master programme in Epidemiology at Maastricht University alongside her physiotherapy studies. She successfully completed both programmes in 2008. In 2009, she obtained her Master of Health Sciences (specialisation: Biology of Human Performance and Health).



Her focus shifted early on to teaching and research, including her role as trial manager of the DUALITY study at Radboud University Medical Center and lecturer in several postgraduate programmes.

In 2017, Esther started her PhD project at the University Medical Center Utrecht, Department of Rehabilitation, Physical Therapy Science & Sports, in collaboration with the research group Innovation of Movement Care at HU University of Applied Sciences Utrecht. Her PhD project, supervised by Professors Cindy Veenhof and Niek de Wit, and co-supervised by Dr. Nienke Bleijenbergh and Dr. Di-Janne Barten, focuses on understanding and supporting functional independence in older persons. Her research resulted in the development and evaluation of a digital decision support tool (DST-FI) and contributes to strengthening person-centred and preventive care in primary care practice.

Throughout her PhD trajectory, Esther remained active in education. She is a lecturer in the Master's programme in Geriatric Physiotherapy and coordinator of the minor in Lifestyle Coaching at HU University of Applied Sciences Utrecht. She is also chair of the expertise group on older persons, project lead within interdisciplinary initiatives and lecturer in the Blended Intensive Programme (BIP) on Global Health, in which she has taught in several European countries. Her work focuses on healthy ageing, interprofessional collaboration, and translating research into practice.

After finishing her PhD, Esther intends to continue combining her work in education with a role in applied health research, contributing to future-proof care for older persons.

She lives in Breda with her partner Sander Roovers and their daughters Reina (2020) and Celine (2022). She is co-founder of Mommunity, a local platform for mothers. Through this initiative, she organises community-based projects such as *de pot op* (in collaboration with the municipality of Breda) and the *Mamacafé* in cooperation with Kober childcare. In her free time, she enjoys playing tennis.

DANKWOORD

Dinsdag 2 juli. De hitte hing als een deken over Breda. Ik zat, zoals zo vaak, alleen achter mijn laptop. Eén druk op de knop, en mijn proefschrift was officieel ingediend. Geen fanfare, geen handen die klapten. Alleen het lege scherm dat terugkeek. Ik sloot het venster, trok haastig een luchtige jurk aan in plaats van mijn te strakke spijkerbroek, en stapte bezweet de auto in. Op weg naar Wageningen, naar het etentje ter afsluiting van het studiejaar. Maar de warmte had ook de snelwegen in zijn greep. File na file. Uiteindelijk draaide ik om. Op de terugweg appte ik Sander over het eten voor de kinderen. Thuis leek alles alsof het een gewone dag was: spelen, bedtijdrutuelen, kusjes. Het proefschrift dat ik die middag had ingediend, kwam die dag niet meer ter sprake.

Toch leerde juist dat moment me hoe belangrijk anderen zijn. Wie fysieke zelfredzaamheid bestudeert, ontdekt al snel dat het niet om één enkele vaardigheid gaat, maar om een samenhang van componenten. Tijdens dit promotietraject ontdekte ik dat hetzelfde geldt voor een promovendus. Het vraagt cognitieve veerkracht om steeds opnieuw kritisch te denken, fysieke discipline om dagen achter een scherm te doorstaan, sociale verbondenheid om de eenzaamheid van onderzoek te verzachten en een omgeving die ruimte geeft om te groeien. In dit dankwoord wil ik degenen bedanken die deze componenten voor mij hebben belichaamd en zonder wie dit boek er niet had gelegen.

Allereerst wil ik mijn promotoren, **Cindy Veenhof** en **Niek de Wit**, bedanken. Cindy, jouw kritische blik en doortastende aanpak waren soms uitdagend, maar hebben mij als onderzoeker laten groeien. Je praktische insteek en scherpe commentaar hielpen me steeds verder. Daarnaast waardeer ik hoe je de samenhang en teamgeest binnen de onderzoeksgroep hebt versterkt, wat dit traject niet alleen leerzaam maar ook verbonden maakte. Niek, jouw brede kennis en rustige wijze van begeleiden boden telkens een nieuw perspectief en hielpen mij om het bredere plaatje te blijven zien. Ik waardeer het enorm dat je, ook nadat je met pensioen ging, zo betrokken bleef en steeds snel en bereikbaar was. Samen hebben jullie mij gesteund in de vrijheid om mijn eigen pad te volgen en tegelijkertijd richting gegeven waar dat nodig was. Ook mijn co-promotor, **Nienke Bleijenberg**, wil ik bedanken. Jouw enthousiasme en oog voor detail hebben mij vaak verder geholpen. Met je praktische tips en betrokkenheid wist je steeds de juiste balans te vinden tussen bemoediging en aanscherping, wat ik erg heb gewaardeerd.

Een speciaal woord van dank wil ik richten aan jou, **Di-Janne Barten**. Vanaf het begin van mijn promotietraject tot aan het indienen van dit proefschrift ben jij voor mij een constante bron van steun geweest. Wat ons samenwerken bijzonder maakte, is dat we als persoon zo verschillend zijn: waar ik eindeloos kan twijfelen en moeite heb met keuzes maken, ben jij juist doortastend en besluitvaardig. Juist dat contrast maakte dat ik enorm veel aan jouw begeleiding heb gehad. Jouw scherpe blik, betrokkenheid en vermogen om precies de juiste vragen te stellen, hielpen mij steeds weer verder. Je combineert kritische feedback met een oprechte warmte, waardoor ik me altijd gesteund voelde. Ook in de eenzame momenten van dit traject. Ik bewonder jouw bevologenheid en de manier waarop

je wetenschap weet te verbinden met de praktijk. Zonder jouw begeleiding en vertrouwen had dit proefschrift er nooit zo uitgezien.

Ik wil tevens de leden van de promotiecommissie bedanken: **Annet van Royen-van Kerkhof**, **Marielle Emmelot-Vonk**, **Thomas Hoogeboom**, **Hans Hobbelen** en **Henk Schers** voor de tijd en aandacht die jullie hebben besteed aan het beoordelen van mijn proefschrift en voor jullie rol tijdens de verdediging.

Lieve **Celine** en **Mark**, mijn paranimfen. Wat ben ik dankbaar dat jullie naast mij staan tijdens de verdediging. Celine, we leerden elkaar kennen in Maastricht. Samen gingen we naar Oxford voor onze masterthesis, je logeerde vaak bij mij in Maastricht en sindsdien zijn we altijd close gebleven. Ik ben zo blij dat we nog steeds zo'n hechte vriendschap hebben en dat we nu ook met onze kinderen samen mooie momenten beleven. Dat je vanuit Haarlem naar Eindhoven bent verhuisd maakt dat we elkaar nu nog vaker zien en dat koester ik enorm.

Mark, mijn liefste collega-bestie. Zonder jou was dit promotietraject echt een stuk zwaarder geweest. Ik houd van onze koffiemomenten, van het samen lesgeven in de minor en van alle steun die je me hebt gegeven. Jij was er om me te troosten, me op te peppen en me steeds weer een duwtje vooruit te geven. Dankjewel dat jij er altijd was, met je humor en je vriendschap.

Daarnaast wil ik mijn collega's uit de groep Fysiotherapiewetenschap en het lectoraat bedanken. Jullie maakten dit traject lichter en leuker, zowel inhoudelijk als in de momenten daarbuiten. Hoogtepunten voor mij waren de congressen in Genève en Dubai, waar hard werken werd gecombineerd met inspiratie en plezier. Met **Anne**, **Elja** en **Mark** vormde ik vanaf het begin een clubje dat in hetzelfde promotieschuitje zat. Het samen delen van ervaringen, twijfels en successen gaf veel steun en herkenning. Ook met mede-promovendi **Mohammed** en **Rutger** heb ik waardevolle gesprekken gehad die mij verder hielpen. **Heidi** en **Hannelies**, dank voor het altijd klaarstaan en meedenken in praktische oplossingen, of het nu ging om de planning of een budgetaanvraag. Dank aan jullie allemaal voor de kritische blikken, de gesprekken en de gezelligheid die dit promotietraject zoveel rijker hebben gemaakt.

Ook mijn collega's uit het onderwijs wil ik bedanken. Binnen de master Geriatriefysiotherapie heb ik met veel plezier samengewerkt. **Brenda**, dank voor je steun en betrokkenheid als leidinggevende, je gaf me de ruimte en het vertrouwen om mijn werk goed te doen. **Carla**, jij in het bijzonder: samen jaar 3 van de master geven was niet alleen inspirerend, maar je hebt me ook altijd ontzettend geholpen door stukken mee te lezen en mee te denken over de invulling ervan. Dat waardeer ik enorm. Ook mijn oud-collega's **Ina**, **Marjan**, **Tiny** en **Mieke** ben ik dankbaar voor hun steun en het werkplezier dat we samen hebben gehad. Binnen de minor Leefstijlcoaching werk ik nog niet zo lang, maar ik ben er vanaf het begin warm ontvangen, dank daarvoor **Arjan**, **Meta** en de rest van het docententeam. **Tim** en **Jeroen**, dank voor de fijne samenwerking rondom het project Traiectum. *A true highlight of my teaching years has been the BIP project, which was such an enrichment. Thank you **Angelique***

*and my international colleagues **Alesander, Barbara, Kaisa, Ron, João, António, Hege and Irene** for your inspiring collaboration and friendship.*

Graag wil ik **alle deelnemers** aan mijn onderzoeken bedanken. Jullie bereidheid om tijd en ervaringen te delen heeft dit proefschrift mogelijk gemaakt. Zonder jullie openheid was dit onderzoek niet tot stand gekomen.

Daarnaast wil ik de studenten bedanken die hebben meegewerkt aan het onderzoek. In het bijzonder **Sander van Bijsterveld, Yvonne Dockx, Kim Wienk** en **Irma de Kinderen**: jullie hebben met jullie inzet een significante bijdrage geleverd door data te verzamelen en (mee) te schrijven aan artikelen. Jullie betrokkenheid en harde werk heb ik enorm gewaardeerd. En **Yassine El Fahmi**, jij hebt als ICT-student de keuzehulp fysieke zelfredzaamheid tot leven gebracht in een webapplicatie. Dat was soms een clash tussen twee werelden – ik wist niets van ICT en jij niets van de zorg – maar juist daardoor was het zo leuk en leerzaam om met jou samen te werken.

Maya, dankjewel voor het vormgeven van dit proefschrift. Je flexibiliteit toen mijn tijdspad steeds wijzigde en je oog voor detail heb ik erg gewaardeerd.

Een speciaal woord van dank gaat uit naar jou, lieve **mama**. Jij bent een onmisbare steun voor mij en voor de kinderen en daar ben ik je onbeschrijfelijk dankbaar voor. Je begrijpt misschien niet altijd precies wat mijn werk inhoudt, maar je steun is altijd onvoorwaardelijk en je wijst me vaak op wat er écht toe doet in het leven. Het meest koester ik dat je altijd trots op me bent, los van wat ik doe.

Ook **Dick, papa** en **Marion** wil ik bedanken voor jullie steun en belangstelling tijdens dit traject. **Dick**, dankjewel voor alles wat je doet als opa, voor het oppassen en voor de mooie momenten die we samen delen, zoals onze plek in de jury van de grote carnavalsoptocht. **Papa**, jouw interesse heb ik altijd gewaardeerd. **Marion**, ook jij bedankt voor je steun en betrokkenheid. En **Rick**, de allerliefste grote broer: dankjewel dat je er altijd bent. **Marlotte, Ilse, Maaïke, Samira, Ischa** en **Mark**: dank voor de momenten van gezelligheid die juist zo waardevol waren naast het werk aan mijn proefschrift. Lieve **Peter** en **Lea**, dank dat jullie altijd klaarstaan voor ons en dat jullie mij als schoondochter zo warm hebben omarmd.

Sander, jij hebt dit traject van dichtbij meegemaakt: de lange avonden achter mijn laptop, de momenten van twijfel en de kleine overwinningen. Dankjewel dat je er was om te luisteren, te relativeren en de zorg voor ons gezin samen te dragen. Zonder jou had ik dit niet gekund. Lieve **Reina** en **Celine**, jullie weten nog niet hoeveel jullie voor mij betekend hebben in deze periode. Jullie vrolijkheid, knuffels en soms ook de broodnodige afleiding maakten dat ik nooit vergat wat er écht belangrijk is. Jullie maakten dit traject lichter, mooier en zoveel waardevoller. Ik houd zoveel van jullie!

Ook mijn vrienden en vriendinnen wil ik bedanken voor hun steun, gezelligheid en de broodnodige afleiding buiten het werk. **Eefje**, dankjewel dat je met Letters de prachtige kaft en het intermezzo in dit proefschrift hebt ontworpen. **Sanne**, mijn business partner in crime binnen Mommunity: hoe fijn is het om dit avontuur samen te beleven. Mijn tennismaatjes **Britt** en **Sandra**, en al mijn andere teamgenoten: dank voor de ontspanning, beweging en vooral de vele lachmomenten. En lieve **Charlotte**, dankjewel voor je vriendschap, oprechte belangstelling en nabijheid. **Ger, Dyon** en **Cees**, dank voor jullie gezelligheid en de leuke klussen. Jullie allemaal hebben dit traject lichter en rijker gemaakt.

Toen ik mijn proefschrift indiende, leek het een gewone dag die ongemerkt voorbijging. Nu ik het afsluit, weet ik dat het juist de mensen om mij heen zijn die dit traject buitengewoon hebben gemaakt. Niet de grote momenten, maar de knuffels en vrolijkheid van mijn kinderen, de liefde en steun van de mensen die het dichtst bij mij staan, de gesprekken met collega's en de vriendschappen die me gemotiveerd hebben gehouden. Zonder jullie steun was dit proefschrift er nooit zo geweest.



Universiteit
Utrecht