JYU DISSERTATIONS 320

Sini Siltanen

Psychological Resources as Modifiers of the Association Between Mobility Decline and Activity in Old Age

UNIVERSITY OF JYVÄSKYLÄ
FACULTY OF SPORT AND HEALTH SCIENCES

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Esitetään Jyväskylän yliopiston liikuntatieteellisen tiedekunnan suostumuksella
julkisesti tarkastettavaksi joulukuun 11. päivänä 2020 kello 12.

Academic dissertation to be publicly discussed, by permission of
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JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ

JYVÄSKYLÄ 2020

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Permanent link to this publication: http://urn.fi/URN:ISBN:978-951-39-8395-6

ISBN 978-951-39-8395-6 (PDF)
URN:ISBN:978-951-39-8395-6
ISSN 2489-9003

ABSTRACT

Siltanen, Sini
Psychological resources as modifiers of the association between mobility decline and activity in old age
Jyväskylä: University of Jyväskylä, 2020, 103 p.
(JYU Dissertations
ISSN 2489-9003; 320)
ISBN 978-951-39-8395-6 (PDF)

Activity refers to everything a person does. Staying active in later life is important for wellbeing but may be restricted due to age-related mobility decline. This study explored whether cognition, resilience, and coping as psychological resources, i.e., personal reserves that may intervene the stressor-wellbeing relationship, modify the negative associations between mobility decline and activity. In addition, this study investigated whether an active aging counseling intervention affects mobility, physical activity and resilience.

Two different datasets were utilized for the current study: Life-Space Mobility in Old Age (n=848) and its sub-study Life-Space Mobility and Active Ageing (n=206); and Active Ageing – Resilience and External Support as Modifiers of the Disablement Outcome, which consisted of two separate studies: cohort (n=1021) and intervention (n=204). The participants were community-dwelling people aged 75 to 93. Study variables were assessed based on validated self-reports, objective observations and activity monitoring. Mobility was observed from multiple aspects including ability, autonomy and extent.

Those with impaired physical performance and impaired cognition had the greatest odds for walking difficulty compared to those with intact function or deficits in only one or the other. Those with high tenacity and high flexibility scored the highest in life-space mobility and perceived autonomy in outdoor mobility, whereas those with low tenacity and flexibility scored the lowest. High resilience was associated with greater active aging among persons with or without walking difficulty but not among persons reporting the inability to walk 2 km. An individualized active aging counseling intervention improved physical performance, lowered perceived autonomy in outdoor mobility and had no systematic effects on other outcomes.

In conclusion, physical and cognitive decline may have additive negative effects on mobility disability in later life, whereas persistence and mental flexibility may help older people to compensate for functional losses and maintain a higher level of activity. The counseling intervention had inconsistent effects on activity and mobility, and hence it remained unclear whether, and if so, how activity can be promoted in old age.

Keywords: active aging, life-space mobility, walking difficulty, resilience, coping, cognition

TIIVISTELMÄ (ABSTRACT IN FINNISH)

Siltanen, Sini
Psyykkiset voimavarat liikkumiskyvyn ja aktiivisuuden välisen yhteyden muovaajina ikääntyessä
Jyväskylä: University of Jyväskylä, 2020, 103 p.
(JYU Dissertations
ISSN 2489-9003; 320)
ISBN 978-951-39-8395-6 (PDF)

Aktiivisuus viittaa kaikkeen ihmisen toimintaan. Sen määrä voi vähentyä ikääntyessä, kun liikkumiskyky heikkenee. Psyykkiset voimavarat edistävät mielen hyvinvointia ja mahdollisesti selittävät yksilöiden välisiä eroja aktiivisuudessa. Tässä tutkimuksessa selvitettiin muokkaavatko kognitiivinen toimintakyky, resilienssi eli sitkeys sekä sinnikkyys ja joustavuus omien tavoitteiden suhteen oletettuja liikkumiskyvyn heikkenemisen ja aktiivisuuden välisiä negatiivisia yhteyksiä. Lisäksi tutkimuksessa selvitettiin, onko aktiivisena vanhenemista edistävällä interventiolla vaikutuksia liikkumiskykyyn, fyysiseen aktiivisuuteen ja resilienssiin.

Tutkimuksessa hyödynnettiin kahta aineistoa: Iäkkäiden ihmisten liikkumiskyky ja elinpiiri (n=848) -aineistoa, sen osatutkimusta Elinpiiri ja aktiivisena vanheneminen (n=206); ja Aktiivinen vanhuus – AGNES -aineistoa, johon kuului erilliset kohortti- ja interventiotutkimukset (n=1021 ja n=204, tässä järjestyksessä). Tutkittavat olivat kotona asuvia 75-93-vuotiaita henkilöitä. Tutkimuksen muuttujia mitattiin itseraportointiin perustuen ja monitoroimalla sekä havainnoimalla osallistujia.

Kävelyvaikeuksia raportoivat todennäköisimmin henkilöt, joilla fyysisen toimintakyvyn lisäksi myös kognitio oli heikentynyt. Elinpiiriliikkuvuus oli suurin ja koettu ulkona liikkumisen autonomia korkein henkilöillä, jotka olivat sekä sinnikkäitä että joustavia omien tavoitteidensa suhteen. Korkea resilienssi oli yhteydessä aktiivisena vanhenemiseen kävelyvaikeuksia kokevilla, mutta ei henkilöillä, jotka eivät pystyneet kävelemään 2 km matkaa itsenäisesti. Aktiivisena vanhenemista edistävä interventio paransi fyysistä toimintakykyä, heikensi ulkona liikkumisen autonomiaa eikä vaikuttanut merkitsevästi muihin vastemuuttujiin.

Fyysisen ja kognitiivisen toimintakyvyn heikkenemisellä saattaa olla toisiaan vahvistava negatiivinen vaikutus liikkumisvaikeuksien syntyyn. Resilienssi, sinnikkyys ja joustavuus taas voivat auttaa kompensoimaan fyysisen toimintakyvyn heikkenemistä ja täten ylläpitämään aktiivisuutta. Koska intervention tulokset olivat ristiriitaisia ja marginaalisia, jäi vielä epäselväksi voiko aktiivisuutta ylipäänsä edistää tässä kohderyhmässä ja millä tavoin.

Asiasanat: aktiivisena vanheneminen, ulkona liikkuminen, fyysinen toimintakyky, kognitiivinen toimintakyky, resilienssi

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ACKNOWLEDGEMENTS

This study was carried out at the Gerontology Research Center (GEREC) and Faculty of Sport and Health Sciences, University of Jyväskylä, Finland. First, I want to thank all the brisk participants of the Life-Space Mobility in Old Age and Active Ageing – Resilience and External Support as Modifiers of the Disablement Outcome studies, who made the present research possible. In the same breath, I want to thank the Dean of the Faculty of Sport and Health Sciences, Ari Heinonen, who was also a member of the steering group of my PhD project, for giving me the opportunity to conduct my research in such a multidisciplinary and supportive research environment. I also want to express my sincere thanks to Research Director Katja Kokko for always making me feel welcomed and for letting my voice to be heard in the very unique research center GEREC represents.

I thank the official reviewers of this thesis, Professor Martijn Huisman and Senior Researcher Suvi Rovio for the insightful and supportive comments. I also thank Research Professor Seppo Koskinen for agreeing to be the opponent in the public defense of my thesis. I express my sincerest thanks also to Michael Freeman for revising the language of this thesis and all the original papers.

My deepest gratitude, however, goes to the supervisors of my PhD work, Professor Taina Rantanen, Senior Researcher Erja Portegijs, and Postdoctoral Researcher Milla Saajanaho. Taina, I want to thank you for giving me the opportunity to work in the AGNES study project from the beginning and for trusting me with some crucial parts of the research. I am grateful for having been taught by such a scientific intellect. Erja, I appreciate all your valuable scientific advice and constructing way of giving feedback. I always felt like I knew how to proceed after consulting you with my problems. Milla, as we have discussed, this has been a learning process for the both of us. I appreciate how amazingly well you have handled things from day one. I felt that you were always there for me, even for the dumbest questions, and always gave some new perspectives to think about.

Further, I am much obliged to all my co-authors and co-workers at GEREC. I have been lucky to conduct my research as a part of a wonderfully talented, yet warm and supporting group of gerontologists. It has been particularly beneficial to have such many fellow junior researchers to share the journey with. I want to address special thanks to Lotta Palmberg, my fellow doctoral student, with whom we have shared the postgraduate journey from the beginning, and to Anu Tourunen, a visiting postdoctoral fellow at GEREC. I appreciate your unwavering support considering both my work and personal life. You two have become one of my closest friends and in the future, I hope to cherish our relationship even if our professional paths apart. Also Tiia Kekäläinen deserves a thank you for tutoring and guiding me through the last phases of this project amid the COVID-19 pandemic. I have also been supported by people outside the GEREC. Senior Lecturer Sanna Palomäki, my roomie during the whole four years, deserves a big thank you for making my days at the office bright. You have cheered me up on the most devastating days, provided help whenever needed, and most notably, expressed your belief in me openly. I am much obliged to you.

Last, I want to thank the most important persons in my life, all my nearest and dearest, family and friends. Mom and dad, you have always ensured that I can get up if I happen to stumble – also on my way to a PhD degree. I can only wish I could someday love my children as unconditionally as you have loved me and my brothers. Marjo and Jukka, I thank you for the most interesting dinner table conversations. You have made me ponder my work from rather unordinary perspectives, and boy, how educational it has been to discuss with professionals from completely different fields! I also want to thank all my friends, especially Anni, Daria, Riina, Pauliina, Suvi, Inkeri, and Janita for being there for me and helping me live my life to its fullest during the weekends.

Finally, Karri, my love. I have never met a funnier and smarter person than you. In addition to being the most loving and trustworthy partner, you have set a great example of how to succeed in life at a young age. Your ambition, determination, and resiliency, which never stop to amaze me, have encouraged me to continue even through the hardest times during this four-year process. I love you and thank you for sharing this wonderful adventure called life with me. Our fur-baby, Manu, deserves also a thank you for bringing so much joy and laughter to my out-of-work hours and for relieving PhD stress.

Jyväskylä 19.8.2020
Sini Siltanen

This research was financially supported by the European Research Council (grant number 310526 to Taina Rantanen). The content of this thesis does not reflect the official opinion of the European Union. Responsibility for the information and views expressed in the thesis lies entirely with the author.

FIGURES

TABLES

LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following four original publications, which will be referred to by their Roman numbers. The thesis also includes unpublished results.

I. Siltanen S, Portegijs E, Saajanaho M, Poranen-Clark T, Viljanen A, Rantakokko M & Rantanen T. 2018. The combined effect of lower extremity function and cognitive performance on perceived walking ability among older people: a 2-year follow-up study. The Journals of Gerontology: Series A 73(11): 1568-1573.

II. Siltanen S, Rantanen T, Portegijs E, Tourunen A, Poranen-Clark T, Eronen J & Saajanaho M. 2019. Association of tenacious goal pursuit and flexible goal adjustment with out-of-home mobility among community-dwelling older people. Aging clinical and experimental research 31(9): 1249-1256.

III. Siltanen S, Tourunen A, Saajanaho M, Palmberg L, Portegijs E & Rantanen T. 2020. Psychological resilience and active aging among older people with mobility limitations. European Journal of Ageing https://doi.org/10.1007/s10433-020-00569-4

IV. Siltanen S, Portegijs E, Pynnönen K, Hassandra M, Rantalainen T, Karavirta L, Saajanaho M & Rantanen T. 2020. Effects of an individualized active aging counseling intervention on mobility and physical activity: Secondary analyses of a randomized controlled trial. Journal of Aging and Health https://doi.org/10.1177/0898264320924258

As the first author of the original publications, considering the comments from the co-authors, I have drafted the study questions and designs for the publications, prepared the data for statistical analyses, performed all statistical analyses except for one sensitivity analysis, and taken the main responsibility of writing the manuscripts. I have actively participated in the data collection in the Active Ageing (AGNES) -study, of which data were used in Study III. I had also a responsible role in designing and implementing the AGNES intervention study, of which data were used in Study IV. In Studies I and II the author was priviledged to use pre-existing data.

ABBREVIATIONS

AGNES	Active Ageing – Resilience and External Support as Modifiers of the Disablement Outcome
ANOVA	one-way analysis of variance
CD-RISC10	10-item Connor-Davidson Resilience Scale
CES-D	Center for Epidemiologic Studies Depression Scale
CG	control group
CI	confidence interval
COR	conservation of resources
EF	executive function
FGA	flexible goal adjustment
GEE	generalized estimating equation
GLM	general linear model
HR	hazard ratio
ICF	International Classification of Functioning, Disability and Health
IG	intervention group
IPA	Impact on Participation and Autonomy questionnaire
km	kilometer
LISPE	Life-Space Mobility in Old Age
LSA	the Life-Space Assessment
M	mean
mg	milligravity
MIIA	Life-Space Mobility and Active Ageing
MM	marginal mean
MMSE	Mini-Mental State Examination
N	number
OLS	ordinary least squares
OR	odds ratio
PA	physical activity
RCT	randomized controlled trial
SD	standard deviation
SDT	Self-Determination Theory
SE	standard error
SOC	Selective Optimization with Compensation
SPPB	Short Physical Performance Battery
TGP	tenacious goal pursuit
TPB	Theory of Planned Behavior
UJACAS	University of Jyvaskyla Active Ageing Scale
WHO	World Health Organization

CONTENTS

1 INTRODUCTION

Activity refers to everything a person does (Lexico, accessed 19.5.2020). It comprises more than just physical activity and may manifest in multiple ways in old age, e.g., as self-care, social activities and home maintenance. It reflects human behavior, and thus is driven by motivation (Deci & Ryan 2008). As postulated in many theories, activity is a central part of aging well. For example, the widely referenced activity (Havighurst 1961) and continuity theories (Atchley 1993), and the models of successful aging (Rowe & Kahn 1987) and selective optimization with compensation (Baltes & Baltes 1990) hold that continued activity generates positive life experiences in old age. The World Health Organization (WHO) has also issued frameworks that address the role of activity in old age. The International Classification of Functioning, Disability and Health (ICF) considers continued involvement in different life areas central for wellbeing in old age (World Health Organization 2001), while, at the societal level, the Active Aging policy framework aims to promote older people's possibilities for activity that corresponds to their needs, desires and capabilities (World Health Organization 2002). Recently, the active aging framework has also been applied at the individual level, the idea being that older people should be active contributors to their everyday lives. Thus, active aging at the individual level measures the extent of individuals' striving to engage in activities that are in line with their goals, functional capacities and opportunities (Rantanen et al. 2019a). There is also empirical evidence to show that greater activity leads to greater wellbeing in later life (e.g. Warr et al. 2004; Guell et al. 2016; Paggi et al. 2016).

With advancing age, mobility declines and may restrict individuals' possibilities for personally meaningful activity. Mobility describes the ability to move oneself from one place to another either on foot or by using transportation. Optimal mobility refers to the ability to decide where, when and how to move (Satariano et al. 2012). According to the disablement process model, deficits in mobility typically originate from pathologies or aging, which can cause impairments in bodily structures and systems, leading eventually to functional limitations (Verbrugge & Jette 1994). In daily life, compromised mobility may initially appear as difficulties in walking longer distances and in running, since these are complex tasks that require considerable physical and cognitive capacity (Rantanen 2013). Eventually, the decline in mobility may restrict the ability to perform essential activities of daily life (Verbrugge & Jette 1994). Moreover, lack of adequate mobility makes it more difficult to leave the home, use public transportation and access various community amenities (Allman et al. 2006; Rantanen 2013). Typically, mobility starts to decline at an accelerating rate after age 65 and at around age 80, most of the major deficits have begun to take place (Ferrucci et al. 2016).

As mobility is closely intertwined with activity, their association may be reciprocal. In other words, it is possible that greater activity translates into improved mobility, as well as vice versa. Many everyday activities engagegd in by older people, such as attending events, running errands and making social visits, require mobility (Tsai et al. 2016a) and thus may increase physical activity. Previous observational studies have found that striving to engage in meaningful activity predicts greater exercise activity (Saajanaho et al. 2014) and coincides with greater life-space mobility (Saajanaho et al. 2015), which, in turn, is associated with better physical performance, higher perceived autonomy in outdoor mobility (Portegijs et al. 2014a), and fewer perceived difficulties in walking longer distances (Rantakokko et al. 2017). However, no causal evidence of the effects of increased overall activity on mobility and physical activity has thus far been presented.

Old age is not solely about deterioration and impairment. Empirical evidence shows that some older people remain highly active despite functional decline (Hirvensalo et al. 2000a; Morrow-Howell et al. 2014). This implies that personal resources other than physical capacity may also contribute to the inter-individual variability in activity. This study addresses the role of psychological resources in living an active life in old age. In general, psychological resources are viewed as entities that contribute to individuals' mental capacity and intervene in the stressor-wellbeing relationship (Ensel & Lin 1991; Leung & Earl 2012). They may be divided into emotional, motivational and cognitive resources (Leung & Earl 2012). In the context of mobility decline and activity, psychological resources have the potential to slow down or prevent the progression of disability, i.e., difficulty in executing activities of daily life (Verbrugge & Jette 1994). In the present research, cognitive function, resilience and coping were investigated as psychological resources. While intact cognitive function may help older people to move in various environments outside the home (Poranen-Clark et al. 2018a) and thereby maintain activity participation (Poranen-Clark et al. 2018b), decline in cognition combined with mobility deficits may further increase the odds for disability. Psychological resilience refers to the ability to tolerate stress (Dyer & McGuinness 1996). A central attribute of resilience is coping (MacLeod et al. 2016), here described as tenacious goal pursuit and flexible goal adjustment in the face of challenges (Brandstädter & Renner 1990). High resilience and active use of coping strategies may enable more active use of compensatory strategies (Carpentieri et al. 2017) and eventually, facilitate greater levels of outdoor mobility and activity – even in the presence of mobility limitations.

Despite the growing body of evidence on the role of cognitive function for mobility (e.g. Demnitz et al. 2016), their combined assocations with health and functional outcomes remain rather poorly known (Montero-Odasso et al. 2015). Moreover, since most resilience research has focused on children and adolescents, while older populations have only recently begun to receive attention (Smith & Hollinger-Smith 2014), the associations between resilience, coping and mobility in old age have remained unclear. However, as the population of older people continues to grow, the need to identify modifiable factors that can contribute to successful and active aging becomes more urgent. Hence, research at the intersection of these traditionally rather separate fields is required. The purpose of this doctoral research was to investigate whether psychological resources modify the relationship between mobility decline and activity among community-dwelling older people. More specifically, the aim was to establish whether cognitive function, resilience and coping can mitigate the negative effects of mobility decline on activity, or conversely, whether lack of these reserves exposes older individuals to even more restrictions on their activity when mobility decline occurs. A further objective was to investigate the influence of an individualized counseling intervention aimed at promoting autonomous motivation and thereby active aging on resilience and a variety of mobility and physical activity outcomes. The findings of this research lay a foundation for future interdisciplinary hypotheses and help in designing more effective interventions for promoting mobility and overall activity, and ultimately, wellbeing in old age. The findings also contribute to the rather novel discourse on aging that emphasizes the positive sides of old age - how to cope with the inevitable changes in body and mind and yet still live life to its fullest.

2 REVIEW OF THE LITERATURE

2.1 Activity in old age

As defined in Lexico, an English dictionary published by the Oxford University Press (accessed 19.5.2020), *activity* is something "a person or group does or has done". Hence, the term refers to all possible forms of doing, not just to being physically active. In old age, activity may take various forms. For example, it was found in a Finnish observational study that running errands, shopping, going for walks, attending events and making social visits were the most common reasons reported by community-dwelling older people for going outside the home (Tsai et al. 2016a). Older people thus typically engage in similar activities in their everyday lives as people of younger ages. However, as their functional abilities often decline, older people may decrease participation in outdoor, cultural, and group activities (Saajanaho et al. 2016b; Tourunen et al. 2020) and increase participation in passive activities, such as reading, watching TV and talking on the phone (Cho et al. 2018). Furthermore, older people with functional limitations may seek to maintain their social relationships and health, while older people with better health and function may still strive to actively participate in leisure time and physical activities that take place outside the home (Saajanaho et al. 2016b). From the perspective of wellbeing, it is important to be able to engage in activities that are personally meaningful (Havighurst 1961).

2.1.1 Activity and aging well from a theoretical perspective

In gerontology, aging is no longer seen solely as a time of disease and disability but also as a time of growth and wellbeing, in which older people are active and productive agents (Johnson & Mutchler 2014). This shift has evolved over several decades and stems from the idea of *successful aging*, originally propounded in the 1960s. Initially, two psycho-social theories of aging positing that older people may achieve success in aging, that is, maintain higher levels of wellbeing and satisfaction with life with advancing age, were proposed (Johnson & Mutchler 2014). These were the disengagement theory (Cumming & Henry 1961, 14) and the activity theory (Havighurst 1961). These were subsequently complemented by a third theory, the continuity theory (Atchley 1989), which drew on the premises of the activity theory. All three major theories were based on the premise that people change their behavior with advancing age by condensing the variety of activities they had in middle age and decreasing the amount of social interaction (Havighurst et al. 1964). However, each theory has an own perspective on how success is achieved, i.e., what it means to age well.

The activity theory states that greater happiness, joy and satisfaction with life in old age are generated by staying involved in personally valued life situations for as long as possible and by resisting the tendency to reduce the amount of social interaction (Havighurst et al. 1964). More precisely, the theory conceptualizes that by continuing to pursue the activities and attitudes of middle age, people may enjoy more positive life experiences in old age (Havighurst 1961). Another key proposition in this theory is that as people eventually have to relinquish some social roles and activities (for example, with respect to work-life), they need to find substitutes for these in order to achieve greater wellbeing (Havighurst et al. 1964). The continuity theory, developed a couple decades later, takes a similar perspective on the associations between activity and wellbeing. It assumes that, with aging, people aim to preserve and maintain their existing activity patterns, which have been developed based on their preferences and competences during their life span (Atchley 1993). Despite the name of the theory, continuity does not refer to staying unchanged but rather to remaining somewhat consistent with one's past. This means that as activities may become restricted with advancing age, people may try to adapt to changes by applying familiar knowledge, skills, and strategies (Atchley 1993). The disengagement theory in turn, takes the opposite approach to activity in old age, viewing withdrawal from activity and social life as a natural, even desirable, part of aging (Cumming & Henry 1961, 14-15). Both the aging individual and society withdraw from each other, creating opportunities for younger generations to engage in society. In addition, the decrease in everyday activity is initiated personally by the aging individual, who starts to focus more on the self than on other people and objects in the environment (Havighurst et al. 1964). This mutual withdrawal eventually generates a new balance between the aging individual and the surrounding society (Cumming & Henry 1961, 15).

While these three theories may no longer be commonly applied as such, they have a critical place in the history of systematic and comprehensive aging research (Achenbaum & Bengtson 1994). For example, although the idea of behaving and thinking similarly in middle and old age is no longer fully supported (Carstensen 2006), there is now a considerable body of evidence showing that having an active approach to life generates wellbeing in old age. It has been reported that greater overall activity (Warr et al. 2004), leisure time activity (Paggi et al. 2016), social activity (Huxhold et al. 2013), and physical activity (Netz et al. 2005), inter alia, are associated with greater well-being and its different dimensions, including greater self-efficacy, life satisfaction, and positive affect. Also many older people themselves have stated that staying active and avoiding passivity are prerequisites for a good life in old age (Guell et al. 2016; Halaweh et al. 2018).

Two other contemporary approaches to aging well also center on activity in later life. In line with the continuity theory, the model of selective optimization with compensation (SOC), proposed by Baltes and Baltes (1990), emphasizes the importance of staying active, but centers more on people's adaptive capacity. More precisely, according to the SOC model, older people may use selection (choosing the most meaningful goals), optimization (acquiring means that are best suited to achieve chosen goals) and compensation (acquiring new resources or activating unused ones) as adaptive strategies to maintain desired behavior and thereby a balance between age-related losses and gains in wellbeing (Baltes 1997). The theory has been supported empirically, as positive correlations have been found between the use of SOC strategies and indicators of successful aging, including subjective wellbeing, positive emotions, and absence of feelings of loneliness (Freund & Baltes 1998). The second more contemporary approach to ageing well is the model of successful aging by Rowe and Kahn, which was originally developed to distinguish between "exceptionally well" and "usually" aged persons (Rowe & Kahn 1987). In this model, successful aging is achieved by older persons who maintain an active engagement with life and intact health and functioning (Rowe & Kahn 1987; Rowe & Kahn 1997). Despite being one of the most ubiquitous models of aging well, Rowe and Kahn's model has also been strongly criticized for applying to a small minority of older people and for correlating poorly with older persons' own perceptions of successful aging (Strawbridge et al. 2002; McLaughlin et al. 2012; Rowe & Kahn 2015; Pruchno & Carr 2017).

2.1.2 Active aging

During recent years, a new framework of aging well, *active aging,* has become increasingly popular in aging research, innovation programs, and policy (Rantanen et al. 2018). Compared with the established successful aging model of Rowe and Kahn (1987), this framework also centers on the importance of activity in later life, but describes a process rather than reflects an outcome, applies also to those with limitations and disabilities, and instead of containing only objective criteria, considers older people's own preferences. Active aging was first introduced as a global policy goal. The European Union defined active aging as follows: "people stay in charge of their own lives for as long as possible as they age and, where possible, contribute to the economy and society" (European Commission 2019). The World Health Organization, in turn, issued an Active Aging policy framework (World Health Organization 2002), in which they stated that active aging is a "process of optimizing opportunities for health, participation, and security in order to enhance quality of life as people age". In this framework, special emphasis was placed on continued participation according to one's needs, desires and capacities. To measure active aging for research purposes, the Active Aging Index was developed. The Active Aging Index ranks countries according to several indicators, such as employment, participation in society, and an enabling environment (Karpinska & Dykstra 2015) and, thus measures active aging at the societal level.

Although widely used in political circles and recently also in research, surprisingly little consensus exists on what active aging means at the individual level and how it can be measured. It has been suggested that active aging could be the outcome of "low probability of illness and disability, high physical fitness, high cognitive functioning, positive mood and coping with stress, and being engaged with life" (Fernández-Ballesteros et al. 2013). However, this definition closely resembles the definition of successful aging proposed by Rowe and Kahn (1987), and does not include mention of a person's possibilities for a meaningful and active life. The concept of active aging has also been equated with physical activity (Bauman et al. 2016), which, in turn, is a rather narrow definition, bearing in mind the various forms of activity older people are able and willing to engage in.

To target this inconsistency, a new definition of active aging at the individual level was recently proposed: "striving for well-being through activities relating to a person's goals, functional capacities, and opportunities" (Rantanen et al. 2019a). This is an objective that can also be achieved by people with disabilities and limitations. In addition, as personal goals and preferences occupy a key role, active aging may take diverse forms. The key role of personal goals also underlines the idea that not everyone should be doing everything – it is more important that people do things that are meaningful for them. In line with the COM-B system (Michie et al. 2011), according to which capability (C), opportunity (O), and motivation (M) interact to generate behavior (B), the new definition of active aging incorporates four aspects: willingness, ability, autonomy, and activity. This entirety is thought to be influenced by health and function and to have an impact on disability and wellbeing (Rantanen et al. 2018).

For empirical purposes, a quantitative 17-item active aging questionnaire was created and validated (Rantanen et al. 2019a). The instrument comprises several activities, such as physical exercise, helping others, practicing memory, enjoying the outdoors, and balancing personal finances. Each activity is assessed from the four aspects of active aging (willingness, ability, autonomy, and activity) (Rantanen et al. 2019a). Due to the novelty of the definition and its measurement instrument, empirical studies reporting on this conceptualization of active aging are to date scarce. However, a large population-based cohort study, of which the present study forms part, investigating the phenomenon of active aging is ongoing, and preliminary analyses have suggested that higher active aging scores correlate with better quality of life, perceived health and autonomy, and with greater life-space mobility (Rantanen et al. 2019a). This implies that active aging may be a central contributor to well-being in later life. Study of the factors that underlie and accompany active aging is warranted as the results may help "ensure that the increasingly longer lives of older people are worth living", as stated by Rantanen et al. (2019a).

2.1.3 Physical activity in later life

Physical activity is a common form of activity. It refers to any bodily movement that is produced by skeletal muscles and leads to energy expenditure (Caspersen et al. 1985). In Finland, older persons have reported physical activity as their most important leisure activity and walking as the form of physical activity they most commonly engage in (Karvinen et al. 2012). Other popular forms of physical activity among Finnish older persons include exercising at home, cycling, swimming, and skiing (Karvinen et al. 2012).

Studies have consistently shown that physical activity declines with advancing age (Milanović et al. 2013; McPhee et al. 2016; Husu et al. 2018; Lounassalo et al. 2019). To achieve the greatest health benefits, according to international physical activity guidelines, older people should avoid long periods of sitting, engage in moderate to vigorous activity several times a week and incorporate muscle-strengthening, aerobic and balance-improving exercises (US Department of Health and Human Services 2018). However, in a representative sample of Finnish older adults, 78% of men and 83% of women aged 75 or older did not meet these physical activity recommendations (Mäkinen et al. 2012). For those between ages 30 and 44, the corresponding proportions were 47% and 42%, and for those between ages 55 and 64, they were 59% and 53% (Mäkinen et al. 2012). This age-related decline in physical activity may be due not only to increased physical limitations and fears about one's ability to undertake physical activity, but also to lack of interest (Crombie et al. 2004). Hence, to promote physical activity, older people's beliefs should be changed and their motivation to engage in physical activity supported (Crombie et al. 2004).

Staying physically active is important for older people as physical activity has several health benefits. For example, greater physical activity decreases the odds for numerous risk factors, such as overweight and obesity, and high blood pressure (US Department of Health and Human Services 2018). Higher levels of physical activity are also associated with smaller risk of all-cause mortality and many chronic conditions, such as cardiovascular diseases, diabetes, cancer, and hypertension (Warburton et al. 2006; Lee et al. 2012). In addition, physically active older persons are less likely to develop cognitive impairment, dementia or Alzheimer's disease (Reiner et al. 2013). Physical activity also helps maintain physical function and independence in later life (Hirvensalo et al. 2000a; Pahor et al. 2006; Metti et al. 2018).

Various aspects of physical activity can be assessed: 1) mode or type (e.g., walking, resistance training), 2) the frequency (number of sessions), 3) duration, and 4) intensity (rate of energy expenditure) (Strath et al. 2013). These aspects may be assessed with self-reports or with wearable monitors. Self-report questionnaires and interviews are typically less burdensome and less costly to administer in large population-based studies whereas wearable activity monitors often provide more standardized and detailed information about the intensity and amount of activity (Loney et al. 2011). Among older populations, physical activity has traditionally been assessed by questionnaires, although body-worn accelerometers have also increased popularity as a data collection method during recent years (Taraldsen et al. 2012).

2.2 Mobility as a determinant of activity

In heterogeneous populations of older people, the possibilities for participation in meaningful activities vary widely (World Health Organization 2002). One explanation for inter-individual differences in activity lies in mobility. As defined in the International Classification of Functioning, Disability and Health (ICF) (World Health Organization 2001), mobility is any movement that relates to changing body position or location, transferring from one place to another, carrying, and moving or manipulating objects. It refers to movement on foot or enabled by assistive devices or means of transportation (Webber, Porter & Menec 2010) and, optimally, is the ability to safely and reliably go wherever, whenever, and however one wants (Satariano et al. 2012). Consequently, mobility is a central asset that enables access to community amenities and the maintenance of social roles (Rantanen 2013). Furthermore, as many everyday activities, such as shopping, running errands, attending events and making social visits require moving from one place to another, adequate mobility is needed to maximize possibilities for participation in such essential life areas. Lastly, mobility is considered the physical ability of most relevance for quality of life and has the strongest prognostic value for disability and survival (Ferrucci et al. 2016).

2.2.1 Various aspects of mobility

As stated by Webber et al. (2010), mobility as a holistic construct is affected by numerous psychological, social, environmental, financial and physiological factors (Webber et al. 2010). For example, adequate cognitive processing is needed for safe driving (Owsley et al. 1998) and navigating in out-of-home environments (Schooler 1984). On the other hand, experiencing negative emotions, poorer self-efficacy or depression may lead people to self-restrict their mobility, even when physical abilities would permit it (McAuley et al 2006; Polku et al. 2015). In addition, older people's mobility may be limited by fear of falling (Vellas et al. 1997), fear of moving outdoors (Rantakokko et al. 2009), or poor financial situation (Shumway-Cook et al. 2005). Naturally, individuals' living environment also plays a role in mobility. For instance, heavy doors, steep stairways, poor street conditions and hilly terrain may block older people's access to outdoors (Rantakokko et al. 2012), whereas having someone to assist them in moving from one place to another may increase their mobility (Baker et al. 2003). These findings show that mobility is not only about physical capabilities. Instead, since mobility comprises all movement within the home and community whether on foot or via the use of assistive devices or vehicles, it can be understood as an umbrella term for many modes of transit. To study mobility in a holistic manner, this study adopted three perspectives on mobility: ability (what the person is capable of doing), extent and amount (what the person actually does), and autonomy (perceived possibilities to attain mobility goals). In this study, mobility ability was indicated as lower extremity performance and perceived limitations in walking, the extent and frequency of mobility as life-space mobility, and autonomy in mobility measured as individuals' perceptions of their possibilities in moving outdoors.

Mobility, in all its diversity, may be assessed by self-reports or by observing and monitoring participants. While combining these methods and studying participants' mobility both in their free-living environment and in standardized tests presents an opportunity for a more in-depth understanding of a person's overall mobility, it has thus far been rarely done (Ross et al. 2013; Rosso et al. 2013). Real-world mobility, in particular, has been under-researched (Ross et al. 2013; Rosso et al. 2013).

In the present study, physical performance, manifested as lower extremity function, was measured with an objective test that requires observing the participant. Such standardized physical performance tests, based on predetermined criteria, evaluate maximal performance in specific physical tasks (Guralnik et al. 1989) and thus provide comparable and detailed information on individuals' mobility abilities. How well individuals perform in such tests is greatly dependent on both their physiological features and the environment in which the test is carried out. It should be noted that a small risk of injury related to physical performance tests is always present (Guralnik & Ferrucci 2003).

As many objective physical performance tests often tell more about the maximal mobility of an individual under controlled circumstances rather than about what the individual is actually able to do in his/her daily life (Giannouli et al. 2016), self-report measures of mobility are also needed. In this study, life-space mobility and perceived difficulties in walking were self-reported. Life-space mobility describes the extent and amount of mobility in different environments, and the level of assistance needed for moving in these areas (Peel et al. 2005; Allman et al. 2006). Consequently, life-space mobility reflects the individual's opportunities to access community amenities and thus indicates not only mobility decline but also social isolation (Sawyer & Allman 2010). Perceived walking difficulties over a longer distance, for example the 2 km distance used here, reflect early-phase decline in mobility ability (Mänty et al. 2007). By assessing walking difficulties with self-reports, it is also possible to capture the intermediate stage between high functioning and mobility limitation, a phase describing pre-clinical decline in walking ability (Fried et al. 2000; Fried et al. 2001). During this stage, walking performance is modified but the difficulty is not yet perceived (Mänty et al. 2007). Typical walking modifications include a slower walking pace, rest breaks during walking, use of an assistive device, reduced walking frequency and giving up walking longer distances (Mänty et al. 2007). In addition to denoting pre-clinical mobility limitation (Mänty et al. 2007), walking modifications may reflect compensatory strategies, as these help people to maintain greater outdoor mobility (Rantakokko et al.

2017; Skantz et al. 2019). It is assumed that people's answers to questionnaires on walking difficulty and life-space mobility reflect well their situation in everyday life (Rantanen et al. 2012). Thus, these measures may be more informative about a person's real-world mobility than objective physical performance tests (Rantanen et al. 2013), as they depend on not only an individual's physical abilities, but also on the individual's physical and social environment.

Finally, autonomy in outdoor mobility refers to individuals' perceptions of their possibilities to move in out-of-home environments (Cardol et al. 1999), and is therefore impossible to assess objectively. Autonomy is a fundamental part of mobility and often the ultimate goal of rehabilitation (Cardol et al. 2002). It describes the extent to which individuals are able to control their own lives, regardless of whether or not they perform the activities by themselves (Fallahpour et al. 2011). Optimal autonomy in mobility, then, is typically seen as full control over decisions about where, when and how to move (Wilkie et al. 2006; Portegijs et al. 2016). Self-report measures of autonomy in mobility typically take into account individual needs and meanings given to different (mobility-related) activities (Cardol et al. 2001). Thus, these measures are greatly dependent on individuals' psychological features and their social environment.

Figure 1 maps all the aspects of mobility discussed above in four dimensions: personal physiological, personal psychological, environmental physical and environmental social. These dimensions represent the background factors that may affect an individual's mobility. Physical performance, which is mainly dependent on the individual's physiology, is located to the upper left corner. In contrast, perceived autonomy in outdoor mobility is more dependent on the individual's social relations, surrounding environment, and mental wellbeing, and thus is located on the right side of the map. As can be seen from the figure, the different aspects of mobility are all related but not overlapping and combined provide a comprehensive view of an individual's overall mobility.

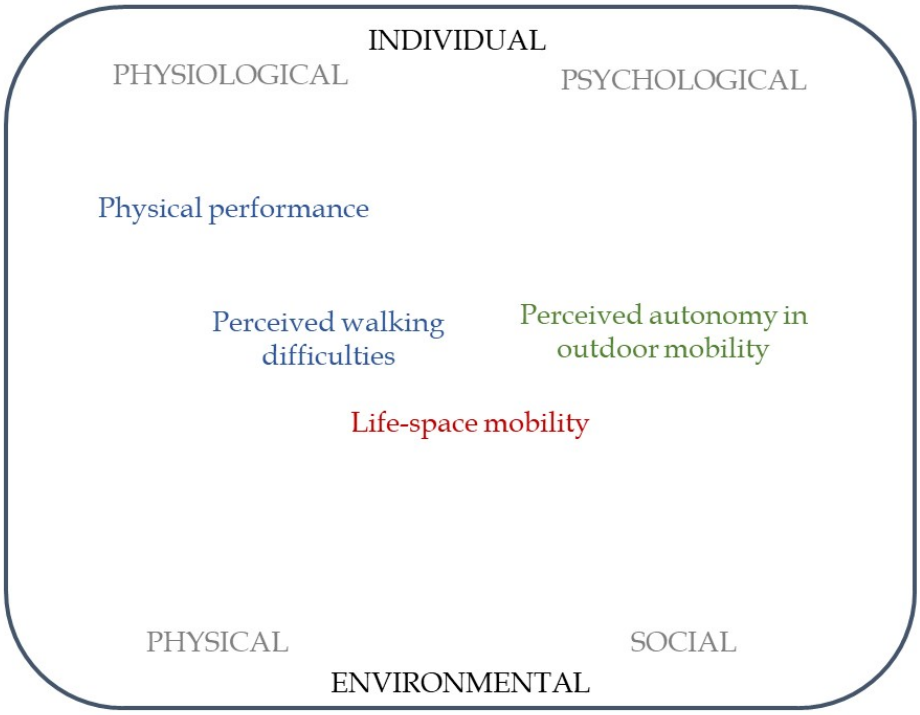

FIGURE 1 Aspects of mobility considered in the present study. They are located on the map according to which environmental or personal features are likely to affect them the most. Physical performance and perceived difficulties are considered as markers of mobility abilities (blue font), life-space mobility as a marker of the extent and amount of mobility (red font), and perceived autonomy in outdoor mobility as a marker of autonomy in mobility (green font).

2.2.2 Progression of mobility decline in old age

Mobility declines with advancing age. Although some changes in mobility may manifest already in rather young adulthood and middle age, mobility decline accelerates after age 60 and many major deficits that may affect everyday life typically take place after age 80 (Ferrucci et al. 2016). The first signs of mobility decline can be observed in complex and challenging mobility tasks, which require greater physical capacity and higher order cognitive processing than is usually the case (Shumway-Cook et al. 2007; Ferrucci et al. 2016). Among such tasks are walking longer distances and running (Rantanen 2013a). In addition, moving farther away from the home increases the complexity of the factors that impact mobility (Webber et al. 2010). For this reason, as functional decline occurs, it becomes more difficult to perform mobility tasks outside than inside the home.

Theoretical considerations

Mobility decline is often discussed in the context of disability, which refers to having difficulties in executing tasks of daily life (Verbrugge & Jette 1994). The disablement process model, developed by Verbrugge and Jette (1994), is an established socio-medical model explicating the pathway from pathology to disability through bodily impairments and functional limitations. Briefly, the disablement process model posits that impairments derive from pathologies, such as diseases and injuries, or from age-related developmental changes. Impairments may be system dysfunctions or structural abnormalities in the body. These, in turn, expose to functional limitations, i.e., restrictions in performing fundamental physical and mental activities. The end point of mobility decline is disability, e.g., difficulty in preparing meals, doing household chores, shopping, or even bathing, dressing, and eating.

In addition to the main pathway that charts physiological changes, the disablement process model takes cognizance of various individual and environmental factors that may affect the progression of disability. These include risk factors, which may be demographic, social, biological, or behavioral, and which may predispose to pathologies and bodily impairments. The model also defines several intra- and extra-individual factors that may slow down or prevent the disablement process. The extra-individual factors include medical care, external support, and environmental factors, whereas the intra-individual factors comprise lifestyle and behavior changes, psychological coping, and activity modifications.

The World Health Organization continued the work initiated by Verbrugge and Jette (1994) by setting up the ICF, a biopsychosocial framework that explicates the progression of mobility disability and contains components comparable to those in the disablement process model (e.g., body functions, limitations on activities, and difficulty in participation, i.e., engaging in essential life areas) (World Health Organization 2001). However, the two models differ in one important respect: while the disablement process model describes the progression of disability from a solely negative perspective, the ICF also views it from a positive angle (McDonough et al. 2017). More specifically, according to the ICF, maintaining better body functions may promote the ability to perform basic activities, which in turn, may improve possibilities for participation in essential life areas (World Health Organization 2001). The ICF's aim is thus not only to describe the progression of disability but also the possible pathways that prevent it. In addition, in the ICF, the associations between these main components are seen as reciprocal, meaning that greater activity may also help maintain functioning and health (World Health Organization 2001), whereas in the disablement model the associations are more unidirectional, with pathology as the starting point and disability the end point. The present study draws both on the disablement process model and the ICF as together they provide a logical framework for studying the associations between mobility decline, psychological resources and activity. Figure 2 presents these two theories in a single, condensed diagram, which was utilized in designing the current study.

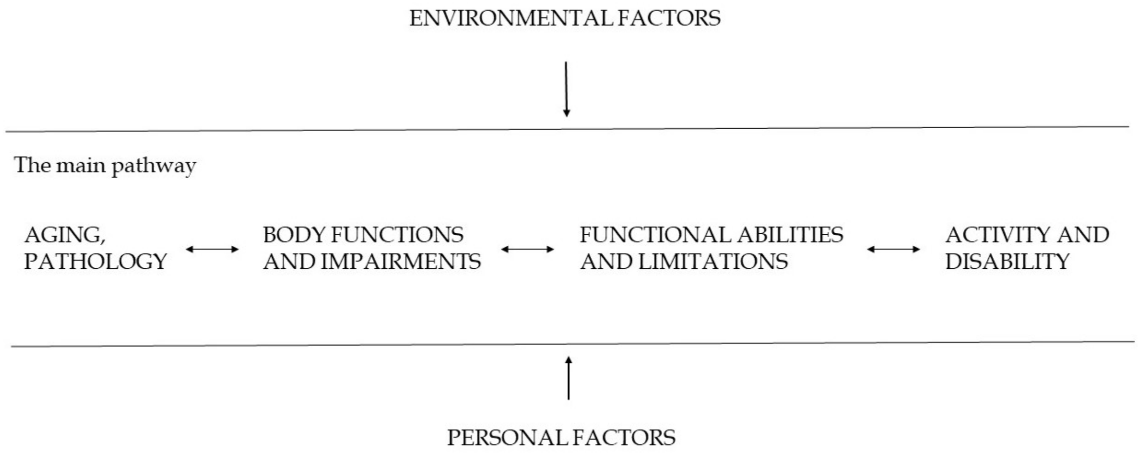

FIGURE 2 Illustration of the progression of mobility decline and disability adapted from Verbrugge & Jette (1994) and the ICF (World Health Organization 2001).

Empirical evidence of mobility decline and its risk factors

Mobility decline has been a popular topic in aging research, and has led to an abundance of evidence showing that most chronic conditions, and even aging itself, negatively affect mobility in older people through various mechanisms related to the musculoskeletal, neurological and cardio-respiratory systems (Rantakokko 2013). For example, depressive symptoms (Penninx et al. 1998; Peel et al. 2005; Snih et al. 2012; Polku et al. 2015), frailty (Portegijs et al. 2016), obesity and a high body mass index (Stenholm et al. 2007; Stenholm et al. 2008), decline in sensory functions, such as hearing impairment (Viljanen et al. 2009), and falls and fractures (Lo et al. 2014) have been associated with an increased risk of mobility decline. In addition to these more pathological factors, fear of moving outdoors (Rantakokko et al. 2009), environmental barriers (Rantakokko et al. 2012; Keskinen et al. 2020) and lower income (Allman et al. 2006), for instance, have also been found to increase the risk of incident mobility limitations and decrease the amount and extent of outdoor mobility.

Earlier studies have found that deterioration in all the aspects of mobility investigated in the present research is common. For example, in a representative sample of Finnish older adults aged 75 and over, as many as 35% of men and 49% of women reported experiencing difficulties in walking 500 m (Sainio et al. 2012). In addition, physical performance, and especially gait speed, have been shown to decline rapidly after age 65 (Diehr et al. 2013). There is also consistent evidence to show that life-space mobility declines with advancing age (Allman et al. 2006; Snih et al. 2012; Phillips et al. 2015; Rantakokko et al. 2017). Moreover, age-related mobility decline is not limited to the physical dimensions of mobility. Deficits in perceived autonomy are also common in later life (Wilkie et al. 2006), and from the perspectives of autonomy, the most restrictions are often observed in autonomy in mobility outdoors (Wilkie et al. 2006; Fallahpour et al. 2011).

Although functional deficits generally become more common with advancing age, the amount and speed of mobility decline varies greatly between individuals (Ferrucci et al. 2016). Men and women may also differ markedly in what aspect of mobility declines first. A recent study showed that deficits in handgrip strength, which is a marker of general muscle strength and a strong correlate of mobility (Rantanen et al. 1994), were more prominent in men than women, whereas women showed bigger changes in walking speed than men (Makizako et al. 2017). Another study found a similar decline in walking speed in both sexes but more evident deficits in handgrip strength in women (Auyeung et al. 2014). In addition, it has been demonstrated that, due in part to menopause, physical performance declines rapidly after the age of 55 in women, whereas in men the decline is more gradual over the whole adult age range (Samson et al. 2000).

2.2.3 Mobility decline and activity restriction

Decline in mobility may restrict an individual's possibilities for activity. In theory, this happens when the competence of a person does not meet the demands of the environment. The ecological theory of aging posits that a correspondence between environmental press and personal abilities affords individuals the maximum potential to do the things they prefer and enjoy a positive life experience (Lawton & Nahemow 1973). In contrast, an imbalance between the individual and the environment, i.e. a case where environmental demands exceed the individual's abilities or are not challenging enough, may lead to maladaptive behavior and negative effects on wellbeing (see Figure 3). Personal competence may refer to functional abilities, whereas environmental demands may refer to obstacles and barriers in the living environment. This theory also places great emphasis on *adaptation* and adaptive behavior. The whole aging process is seen as one of continual adaptation, meaning that to savor positive emotions and wellbeing, people must adapt to changes in both their environment and personal competence throughout the life span (Lawton & Nahemow 1973). In line with this view, the present study assumes that mobilizing different personal resources as a respond to changed life circumstances can lead to desirable behavior, here conceptualized as greater outdoor mobility and activity, and eventually facilitate better quality of life and greater wellbeing.

These significant interactions between person and environment have also been supported in empirical studies, where old age has been found to be one of the phases of life most heavily influenced by the environment (Wahl et al. 2012). It has been shown that environmental barriers predispose older people to mobility decline (Rantakokko et al. 2009; Rantakokko et al. 2012; Keskinen et al. 2020), whereas environmental facilitators may prevent it (Eronen et al. 2014). As mobility declines, people may end up only able to move in a limited range of environments, such as within the home or neighborhood (Patla & Shumway-Cook 1999). This translates as restricted life-space mobility (Allman et al. 2006;

Barnes et al. 2007). Restricted life-space mobility may then lead to lower physical activity (Portegijs et al. 2015; Tsai et al. 2015; Tsai et al. 2016b) and participation in social (Barnes et al. 2007) and intellectual activities (Suzuki 2014). Restricted life-space is also associated with poorer perceived autonomy in outdoor mobility and poorer physical performance (Portegijs et al. 2014a).

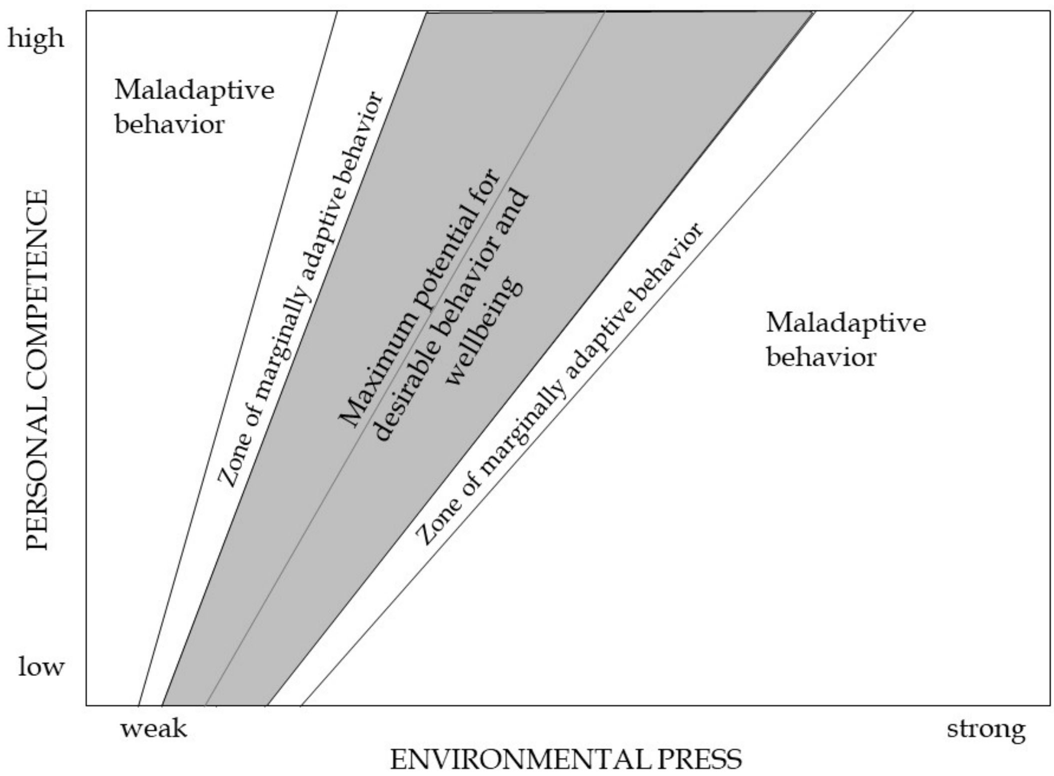

FIGURE 3 Diagrammatic presentation of the ecological theory of aging adapted from Lawton & Nahemow (1973).

As discussed above, it is likely that mobility decline predisposes older people to activity restriction. However, persons with intact mobility may also be sedentary, and others with mobility limitations may also be active (Hirvensalo et al. 2000b). Indeed, it has been found that some older persons with mobility limitations continue to engage in a variety of activities (Morrow-Howell et al. 2014). However, this more positive perspective on aging and activity has received little research attention, and hence it has remained unclear which factors contribute to successful adaptation and greater activity among persons with mobility decline. The present study delves into the role of psychological resources as modifiers of the association between mobility decline and activity.

2.2.4 Promoting mobility and physical activity by active aging counseling

Activity and outdoor mobility reflect human behavior and thus are driven by motivation (Deci & Ryan 2008). Consequently, to change behavior, for example to increase older people's participation in physical activity or other activities outside the home, it is necessary to influence motivational constructs (Knittle et al. 2018). Motivation, in a broad sense, is the "driving force responsible for the initiation, direction and vigor of goal-directed behavior" (Colman 2015). As posited in the self-determination theory (SDT), there are different types of motivation; in fact, for effective performance and wellbeing, the type of motivation may be more important than the amount of motivation (Deci & Ryan 2008). According to the SDT, motivation may be viewed as autonomous, reflecting engagement in behaviors for intrinsic reasons, for example because they are perceived as personally important and meaningful, or as controlled, reflecting engagement in behaviors for extrinsic reasons, for example to earn rewards or to avoid punishment (Deci & Ryan 2000; Hagger et al. 2014). Autonomous motivation is thought to lead to more long-term effects on desirable behaviors and wellbeing than controlled motivation (Deci & Ryan 2008). In addition, in previous systematic reviews and meta-analyses, autonomous motivation in particular has been linked to greater physical activity (Fortier et al. 2012; Ng et al. 2012; Owen et al. 2014).

Interventions that have been successful in promoting physical activity, mobility and other health-related behaviors, have included individualized counseling and personal contact (Mänty et al. 2009; Jepson et al. 2010; Rasinaho et al. 2012; Morris et al. 2014; Williams et al. 2017). Moreover, a recent meta-analysis reported that the inclusion of behavior change techniques, such as self-monitoring and goal setting in physical activity interventions seems to have positive effects on motivation (Knittle et al. 2018). These findings imply that counseling interventions may have the potential to promote motivation as well as physical activity and function.

However, counseling interventions other than those focusing solely on physical activity may also prove fruitful in promoting physical activity and out-of-home mobility. Since mobility and everyday activity are closely intertwined, their relationship may be bidirectional, meaning that while mobility typically affects activity, activity may as well affect mobility. Many activities undertaken by older people in their everyday lives, such as running errands, making social visits, attending events and shopping require mobility and thus increase physical activity per se (Tsai et al. 2016a). Moreover, previous observational studies have shown that striving to engage in any meaningful activity is associated with greater life-space mobility (Saajanaho et al. 2015) and exercise activity (Saajanaho et al. 2014). Hence, promoting participation in any valued activities, not only physical ones, may lead to increased physical activity and promote different aspects of mobility. However, no results on causality in this association have been reported hitherto. Interventions that consider mobility from various perspectives have also been lacking (Ross et al. 2013).

To contribute to filling this gap in mobility research, this study investigated the effects of an active aging counseling intervention on different mobility and physical activity outcomes. The intervention was designed to help participants set new, self-selected activity goals, support their autonomous motivation, and eventually increase the amount of any activity relating to their goals, capacities and possibilities (Rantanen et al. 2019b). The intervention integrated two motivational theories, the self-determination theory (SDT, Deci & Ryan 2000) and the theory of planned behavior (TPB, Ajzen 1985), as this integrated model has been found to help explain health-related behavior, such as physical activity, in an earlier meta-analysis (Hagger et al. 2009). The SDT emphasizes the importance of having intrinsic and self-determined rather than externally regulated and forced motivation for action (Deci & Ryan 2000), whereas the TPB highlights the role of beliefs and intentions as a basis for desirable behavior (Ajzen 1985). The primary analyses showed that the intervention positively affected participants' level of active aging, mainly by enhancing the activity aspect of active aging. However, the effect was small (Rantanen et al. 2020). The present purpose was to perform secondary analyses to establish whether these small but statistically significant changes in overall activity would also translate into improvements in physical performance, perceived walking difficulties, life-space mobility, perceived autonomy in outdoor mobility, and self-reported and objectively monitored physical activity.

2.3 Psychological resources in relation to mobility and activity

Psychological resources may play a role in explaining why some older people retain a higher level of mobility and activity than others. In general, resources are seen as entities that can either be centrally valued as such or act as means to achieve some other valued objectives (Hobfoll 2002). Psychological resources are considered personal entities which act as reserves that help individuals manage and cope with stress and thus facilitate greater wellbeing (Taylor et al. 2000; Ong & Bergeman 2004). They can be more personality-based and stable, or they may change over time (Hobfoll 2002). Psychological resources can be divided into cognitive (e.g. cognitive function), emotional (e.g. positive emotions and emotional intelligence) and motivational resources (e.g. tenacious goal pursuit and flexible goal adjustment) (Leung & Earl 2012).

Psychological resources have typically been examined in the context of stress, adaptation and wellbeing (Ensel & Lin 1991; Hobfoll 2002). A major landmark in health psychology occurred in the late 1970s, with the publication of "Health, Stress and Coping" (1979) by Professor Aaron Antonovsky, in which he introduced his theory of salutogenesis. This theory turned the traditional question on the causes of diseases upside down by focusing on the phenomenon that some people are able to maintain and develop their health and wellbeing even under extremely unfavorable circumstances (Suominen & Lindström 2008). In his investigations of a group of concentration camp survivors, Antonovsky had found that almost a third subsequently reported reasonable mental wellbeing (Antonovsky 2002). This prompted scientific interest in examining the factors that may help people to adapt to adversity that continues to this day.

In developmental psychology, psychological resources have been extensively studied among at-risk children and adolescents (e.g. Ong et al. 2009; MacLeod et al. 2016). In the aging context, psychological resources have mainly been studied in relation to retirement, as it is a phase of life that all older people face and that may be viewed not only as a crisis in which the physical and mental abilities of an aging person are threatened (Barron et al. 1952) but also, as a process that may have beneficial effects on wellbeing (Kim & Moen 2001; Mein et al. 2003). However, as older people are typically more diverse in health, psychological functioning, and social interaction than younger people (Nelson & Dannefer 1992), increasing interest has recently been shown in the adaptation and psychological resources of older populations (e.g. Ong et al. 2009; MacLeod et al. 2016). This study extends the literature on the psychological resources of community-dwelling older people.

2.3.1 Psychological resources in the present study

In examining psychological resources, the present study draws on the theory of the conservation of resources (COR). The COR theory states that people inherently strive towards obtaining and retaining resources, and that if resources are lost or their loss is threatened, they experience stress and potentially, impaired wellbeing (Hobfoll 2002). However, the COR also posits that resources interact and aggregate rather than exist in isolation (Hobfoll 2002). This means that resources are dynamic, and losses in one domain may be compensated by gains in another resource domain. The present study addresses cognitive function, psychological resilience, tenacious goal pursuit, and flexible goal adjustment, and thereby covers the cognitive and motivational aspects of psychological resources. These resources are viewed as individual reserves that may (be) develop(ed) over the lifespan, help cope with age-related losses in other resource domains, in this case mobility, and eventually, facilitate greater activity. In contrast, it is assumed that impaired cognitive function or lack of coping skills may predispose to adverse outcomes, such as mobility disability and restricted activity.

Cognitive function

Cognitive function refers to the ability to become aware of, perceive, and comprehend information. It comprises aspects such as perception, thinking, reasoning, and remembering (Mosby's Medical Dictionary 2013). Cognitive function divides into different functional domains, including memory, attention, problem solving, and processing speed, which can be measured with specific cognitive tests (Brewster et al. 2018). Many daily tasks, such as preparing meals, managing finances, and moving from one place to another require cognitive functioning. Good cognitive function may also be a prerequisite for successful compensation and coping. For example, being able to focus attention, avoid distraction, and react to negative thoughts and ideas in a reflective way may be central in overcoming stressful situations (Parsons et al. 2016). Hence, retaining cognitive function in old age is essential for maintaining independence and quality of life (Salthouse 2004; Brewster et al. 2018). Conversely, poorer cognition may expose to different pathologies, such as Alzheimer's disease (Salthouse 2004) and to diminished well-being (Wilson et al. 2013).

As a result of normal aging, brain structures change and cognitive function declines (Harada et al. 2013). The decline starts slowly already in early adulthood (Salthouse 2004; Harada et al. 2013), and many deficits are evident already in middle age (Singh-Manoux et al. 2012). However, individuals may differ markedly in the rate of decline (Wilson et al. 2002). For example, it has been suggested that women show a lower level of decline in some domains of cognitive function, such as executive function and memory, than men (Zaninotto et al. 2018). In addition to sex, also smoking, alcohol consumption, depression, and physical inactivity (Zaninotto et al. 2018) may explain the individual differences in rate of cognitive decline. Moreover, cognitive decline may be more rapid in old age than in middle age or earlier in adulthood (Wilson et al. 2002), but the variation in cognitive decline between individuals is not necessarily greater in old age than at younger ages (Salthouse 2012). Of the different cognitive domains, memory, reasoning, phonemic and semantic fluency, and processing speed have been shown to decrease with advancing age (Wilson et al. 2002; Singh-Manoux et al. 2012), whereas vocabulary has been shown to remain stable or even improve in old age (Singh-Manoux et al. 2012). However, decline in one cognitive domain is often associated with decline in another domain, implying that cognitive aging happens globally (Tucker-Drob et al. 2019).

In the present study, we focused on global cognitive function as it provides an overview of a person's current cognitive status. Measures of global cognition are typically comprehensive, such as the well-established Mini-Mental State Examination, which incorporates orientation, memory, attention, registration, language, and calculation (Folstein et al. 1975). In previous studies, better global cognition has been associated with, for example, greater life-space mobility (Barnes et al. 2003; Sartori et al 2012), physical (Buchman et al. 2008) and social activity (Krueger et al. 2009) and wellbeing (Davis et al. 2015). In contrast, poorer global cognition has been found to predict, for example, functional decline (Wang et al. 2002; Johnson et al. 2007), functional dependence (Gill et al. 1996) and mortality (Iwasa et al. 2013; Connors et al. 2015).

Resilience

People respond differently to adversities, such as functional decline, which may partially be explained by different levels of psychological resilience. Psychological resilience refers to the ability to adapt positively to adversity and overcome stressful situations (Dyer & McGuinness 1996; Luthar et al. 2000). Like Antonovsky's work on salutogenesis, the history of resilience research also dates back to the 1970s, when it was found that despite living in adverse conditions some children managed to thrive (Luthar et al. 2000). This finding prompted a systematic search for protective factors that might explain why some children adapted to adversity better than others. At first, resilience was thought to be something inherited, and therefore a stable trait, and studies focused on identifying the personal qualities that made for resilience in children (Luthar et al. 2000). Resilience has since been investigated in other populations as well and is nowadays understood as a dynamic process in which several biological, psychological, social and cultural factors interact and generate a response to a stressful situation (Southwick et al. 2014). Hence, resilience is typically thought to manifest only in the presence of a stressor.

Resilience may be understood as a coping style per se (Rutter 2006), although coping is more commonly considered a feature of resilience (Gillespie et al. 2007; Hicks & Conner 2014; MacLeod et al. 2016). Other typical attributes of psychological resilience include high self-efficacy, i.e., confidence in one's own abilities to manage different situations (Bandura 1986), hope, hardiness, and positive self-concept (Gillespie et al. 2007; Hicks & Conner 2014). Another common feature of resilience is goal-orientation, meaning that people with high resilience tend to be determined and persistent in striving towards desired ends (Lamond et al. 2008; Garcia-Dia et al. 2013). Furthermore, people with high levels of resilience have been described as, for example, able to solve problems effectively, look to the future, and accept the current circumstances (Van Kessel 2013) and to have greater social support (MacLeod et al. 2016). People with high resilience, in the ways described above, tend to achieve better outcomes, such as greater wellbeing, than others who have experienced a comparable level of adversity (Rutter 2012). A surrogate term for resilience is sense of coherence (Hicks & Conner 2014) – a key concept in Antonovsky's theory of salutogenesis (2002). Like resilience, sense of coherence refers to a person's ability to respond positively to stressful situations and is essential for achieving better health and wellbeing (Lindström & Eriksson 2005).

Bearing in mind that old age is accompanied by notable changes in health, function, and social relationships, it may be considered as a phase of life in which the ability to adapt is of especial importance. Thus, older people in particular may benefit from higher levels of resilience. Some studies have even found older people to demonstrate equivalent or even higher levels of resilience than young or middle-aged adults (Hamarat et al. 2002; Nygren et al. 2005; Gooding et al. 2012). This may be due to the "steeling" effect of resilience, meaning that experiencing adversity at some points in one's life may increase the likelihood of positive adaptation to stressful situations in the future (Rutter 2006). However, resilience in older people has not been comprehensively studied and whether levels of resilience differ across old age, i.e., whether young-old persons have greater or lower levels of resilience compared to the old-old remains unclear.

Tenacious goal pursuit and flexible goal adjustment

Personal goals refer to self-selected and personalized objectives that people want to achieve, maintain or avoid in the future (Freund & Riediger 2006). They describe the motivational forces and intentions behind our actions, and thus guide our behavior (Ajzen 1985; Baltes 1997) by determining how we invest our time and energy (Smith & Freund 2002; Riediger et al. 2005). In old age, goals are mainly related to health, leisure activities or social relationships (Saajanaho et al. 2016a). It has also been reported that having goals related to exercise and cultural activities is associated with higher exercise activity (Saajanaho et al. 2014). However, these goals may be the first to be relinquished when facing mobility decline (Saajanaho et al. 2016b).

Personal goals are situated within a developmental regulation system of gains and losses, which with advancing age often inclines towards losses (Baltes 1987; Freund & Riediger 2001). In practice, this means that age-related functional decline may limit the potential for action and result in a need to review and modify one's goals (Baltes 1997; Brandtstädter 2009; Saajanaho et al. 2016b). On the other hand, persistence and determination may facilitate the pursuit of current goals. This dual-process model of goal adjustment and goal pursuit was established by Brandtstädter and Renner in the 1990's. Their model of assimilative and accommodative *coping* represents two distinct but complementary coping strategies related to goal pursuit. The first, assimilative coping, or tenacious goal pursuit (TGP), refers to persistence and increased effort in adjusting the actual situation in line with one's aspirations (Brandtstädter & Renner 1990; Brandtstädter 2009). The second, accommodative coping, or flexible goal adjustment (FGA), refers to adjusting one's goals to changed circumstances by disengaging from blocked goals or by downgrading their importance (Brandtstädter & Renner 1990; Brandtstädter 2009). The basic assumption in the dual-process model is that people may use both assimilative and accommodative strategies; investing time and energy in the persistent pursuit of one's goals can be fruitful, but if these efforts prove to be ineffective, it may be more beneficial to modify or abandon those goals in favor of more feasible goals (Bailly et al. 2012).

Tenacity and flexibility aim at reducing disparities between desired and factual situations (Brandtstädter & Rothermund 2002), and thus reflect coping and resilience. Thus far, these coping strategies have mainly been studied in relation to psychological outcomes, and their associations with lower levels of depression and greater life satisfaction have been established (Brandtstädter & Renner 1990; Bailly et al. 2012). In addition, it has been suggested that, in old age, flexibility might be more important than tenacity (Bailly et al. 2012; Martinent et al. 2017). However, a recent study found that tenacity may be more significant than flexibility for being active in one's leisure time in old age (Tourunen et al. 2020). Moreover, there are also findings showing that older people utilizing both strategies have greater life satisfaction and better perceived health than those using only one or the other (Bailly et al. 2016; Kelly et al. 2013).

2.3.2 Cognitive decline and mobility

Emerging, but consistent, evidence from cross-sectional and longitudinal studies demonstrates that decline in physical capacity often co-exists with deficits in cognition (Rosano et al. 2005; Montero-Odasso et al. 2012). Thus, persons who perform poorly in physical tests also tend to score lower in cognitive tests (Clouston et al. 2013), and vice versa (Demnitz et al. 2016). Persons with poorer cognition also tend to have more restricted life-space mobility (Poranen-Clark et al. 2018a). Based on this close relationship between cognition and mobility, two international workshops have come to the conclusion that these should be regarded as a combined research entity, and therefore that mobility studies should incorporate cognitive measures (Montero-Odasso et al. 2015; Varma et al. 2016). Together mobility and cognition may be more predictive of a variety of risks, such as dementia (Hausdorff & Buchman 2013).

It has been suggested that rather than being true risk factors for one another, the joint deterioration of cognition and mobility stems from a common biologic aging process or pathophysiology (Hausdorff & Buchman 2013), although this has not yet been confirmed in longitudinal studies (Clouston et al. 2013). The possibility of a common biologic aging process might explain why researchers have found inconsistent evidence of the temporal associations between mobility decline and cognition. In some studies, it has been suggested that pathological degeneration may be more easily and therefore, earlier detected in gait than in cognition (Morris et al. 2016). Other studies have also supported the sensitivity of gait measures and suggested that deficits may first manifest in walking and only a little later in cognition (Best et al. 2016; Dumurgier et al. 2017). However, it has also been found that cognition predicts mobility decline. For example, poorer global cognition (Atkinson et al. 2010) and poorer executive function (Stijntjes et al. 2017), a higher order domain of cognition, have been shown to precede decline in physical performance and gait, but not the other way around (Atkinson et al. 2010). Similarly, a recent two-year follow-up study found that executive function predicted life-space mobility, but not vice versa (Poranen-Clark et al. 2018b). Moreover, some studies have reported that the associations between cognitive decline and mobility decline may be bidirectional, i.e., either one can be the precursor or the outcome (Watson et al. 2010; Tian et al. 2017).

Despite the growing evidence linking mobility and cognitive decline in old age, the risks and consequences of this combination have not been studied thoroughly. Thus far, it has been reported that self-reported cognitive decline together with slowed gait increases the risk for dementia (Verghese et al. 2012; Montero-Odasso et al. 2016), mortality (Ayers & Verghese 2016; Beauchet et al. 2019) and falls (Callisaya et al. 2016). A joint association of self-reported cognitive decline and slowed gait with cardiovascular diseases and their risk factors has also been found (Beauchet et al. 2018). However, as the findings were from a cross-sectional study, the temporal associations remained unclear. In addition, objectively measured cognitive decline together with self-reported mobility limitations has been shown to increase the risk of institutionalization (von Bonsdorff et al. 2006). However, the question whether the combination of cognitive and physical decline is associated with perceived walking difficulties has remained unstudied, despite the rather strong association that has been found between walking ability and cognition (Rosano et al. 2005). The present objective was to investigate the potential joint association of cognitive decline and physical performance decline with prevalent walking modifications and difficulty and with incident walking difficulty.

2.3.3 Resilience, coping and activity

Unlike cognitive function, which may be a resource that diminishes with advancing age, resilience and coping may be resources that older people can more easily harness. Earlier studies have shown that higher resilience is associated with several health outcomes, such as lower depression (Wermelinger Ávila et al. 2017), lower mortality risk (Shen & Zeng 2010), fewer cognitive complaints, greater emotional wellbeing (Lamond et al. 2008), and better perceived health (Wells et al. 2012). In addition, higher resilience has been shown to correlate with better physical performance, quality of life and self-rated successful aging (Lamond et al. 2008; Tourunen et al. 2019). With respect to behavioral outcomes, higher resilience has been linked to higher physical activity (Perna et al. 2012; Resnick et al. 2018) and more active social engagement (Lamond et al. 2008; Levasseur et al. 2017). However, whether resilience is associated with overall activity, and whether it can alleviate the negative associations between mobility decline and activity are currently not known. Hence, the present objective was to examine the relationship between resilience, walking difficulties and active aging.

Having and pursuing personal goals may encourage people to extend their life-space and continue participation in preferred activities (Baltes 1997; Barnes et al. 2007; Tourunen et al. 2019a). In previous studies, goal pursuit has been linked to greater exercise activity (Saajanaho et al. 2014), life-space mobility (Saajanaho et al. 2015) and better life resources (Saajanaho et al. 2016a). Tenacious goal pursuit has also been found to increase leisure time activity among people with decreased physical performance (Tourunen et al. 2020). Based on these findings, it is likely that flexible goal adjustment and tenacious goal pursuit are also associated with greater mobility outside the home. However, empirical studies have paid only minimal attention to these separate but complementary coping strategies in relation to mobility outcomes. This study targeted this research gap by examining whether high tenacity and flexibility underlie greater out-of-home mobility among older people.

Finally, it is possible that an intervention that supports autonomous motivation for goal pursuit provides social support and uses behavioral change techniques, such as problem solving and action planning in promoting meaningful activity, improves resilience. As is made clear in the American Psychological Association's (APA) toolkit to build resilience (2012), these factors and techniques, including increased meaningful activity, are central for improving adaptation to life-changing situations. In addition, findings from a previous intervention suggest that increased participation in any out-of-home activity can improve the physical domain of quality of life, a correlate of resilience (MacLeod et al. 2016), even in older people with severe mobility limitations (Rantanen et al. 2015). Moreover, resilience, measured with the same method as here, i.e., with the Connor-Davidson Resilience Scale, has been shown to be sensitive to positive changes in previous trials (e.g. Steinhardt & Dolbier 2008; Loprinzi et al. 2011; McGonagle et al. 2014). However, these studies were conducted among college students (Steinhardt & Dolbier 2008), breast cancer survivors (Loprinzi et al. 2011), and among workers with chronic conditions (McGonagle et al. 2014). To understand whether resilience can also be promoted among community-dwelling older populations, this study investigated the effects of an individualized active aging counseling intervention on a secondary resilience outcome.

2.3.4 Framework of the study

To deepen understanding of the factors underlying greater participation in meaningful activity in old age, and to shift the focus away from age-related deficits and disability to the existing potential of older people, this study targeted the modifying and mediating associations of psychological resources with mobility and activity. The study's main constructs and their definitions are summarized in Table 1.

As described in this literature review, several theories were employed as a theoretical background for this study, as the interdisciplinary research questions and aims of the study extended beyond the reach of any single theory. Consequently, this study incorporated components of various – yet partially similar and overlapping – theories and models. The study framework was based mainly on 1) the International Classification of Functioning, Disability and Health (ICF; World Health Organization 2001), which aided understanding of the associations between mobility decline and activity; and 2) the model of selective optimization with compensation (SOC; Baltes & Baltes 1990); and 3) the theory of conservation of resources (COR; Hobfoll 2002), which aided understanding of the relationships and adaptation processes between personal resources and activity. In addition, in the individual sub-studies, other theories, including the ecological theory of aging (Lawton & Nahemow 1973), the self-determination theory (Deci & Ryan 2000), and the dual-process model of assimilative and accommodative coping (Brandstädter & Renner 1990) were utilized to understand the role of the environment and motivation behind older people's actions. Moreover, the framework of the present study was based on established theories rather than on empirical findings, as the relationships between cognitive function, resilience, coping, early-phase mobility decline and active aging have been rather sparsely studied.

TABLE 1 Summary of the main constructs in the present study.

CONSTRUCT	DEFINITION
Activity	Everything a person does (Lexico 2020)
Active aging	*Striving for wellbeing through activities pertaining to one's goals, abilities, and opportunities (Rantanen et al. 2019a)*
Physical activity	*Any bodily movement produced by skeletal muscles leading to energy expenditure (Caspersen et al. 1985)*
Mobility	Ability to move from one place to another either on foot or by using transportation (Satariano et al. 2012)
Physical performance	*Maximal performance in certain physical tasks (Guralnik et al. 1989); reflects mobility ability*
Walking difficulties	*Perceived difficulty walking in one's living environment (Mänty et al. 2007); reflects mobility ability*
Life-space mobility	*Extent and amount of mobility in different environments, and the level of assistance needed for moving in these areas (Peel et al. 2005)*
Autonomy in outdoor mobility	*Perceived possibilities to move in out-of-home environments (Cardol et al. 1999)*
Psychological resources	Personal reserves that contribute to mental health and help cope with adversity (Taylor et al. 2000; Ong & Bergeman 2004)
Cognitive function	*Ability to become aware of, perceive, and comprehend information (Mosby's Medical Dictionary 2013)*
Resilience	*Ability to adapt positively to adversity and overcome stressful situations (Dyer & McGuinness 1996)*
Coping	*Tenacity and flexibility in goal pursuit (Brandtstädter & Renner 1990); part of resilience (Hicks & Conner 2014)*

Figure 4 presents the conceptual framework of this study. Age-related mobility decline is taken as the starting point. With advancing age, deficits may occur either in mobility abilities, the extent and amount of mobility, or in autonomy in mobility. Psychological resources describe how well or poorly older people adapt to deficits in their mobility. It is assumed that losses in mobility may be compensated by higher resilience, active use of coping strategies and better cognitive function. In contrast, poorer outcomes are more likely to occur if not enough cognitive resources are available, or if motivational resources (coping, resilience) are ineffectively utilized. Ultimately, the interactions between mobility and psychological resources define to what extent older people can engage in meaningful activities and savor positive life experiences. Furthermore, it is assumed that the pathway from mobility to activity is reciprocal. More specifically, this means that by influencing activity, it may be possible to positively affect the maintenance of resources.

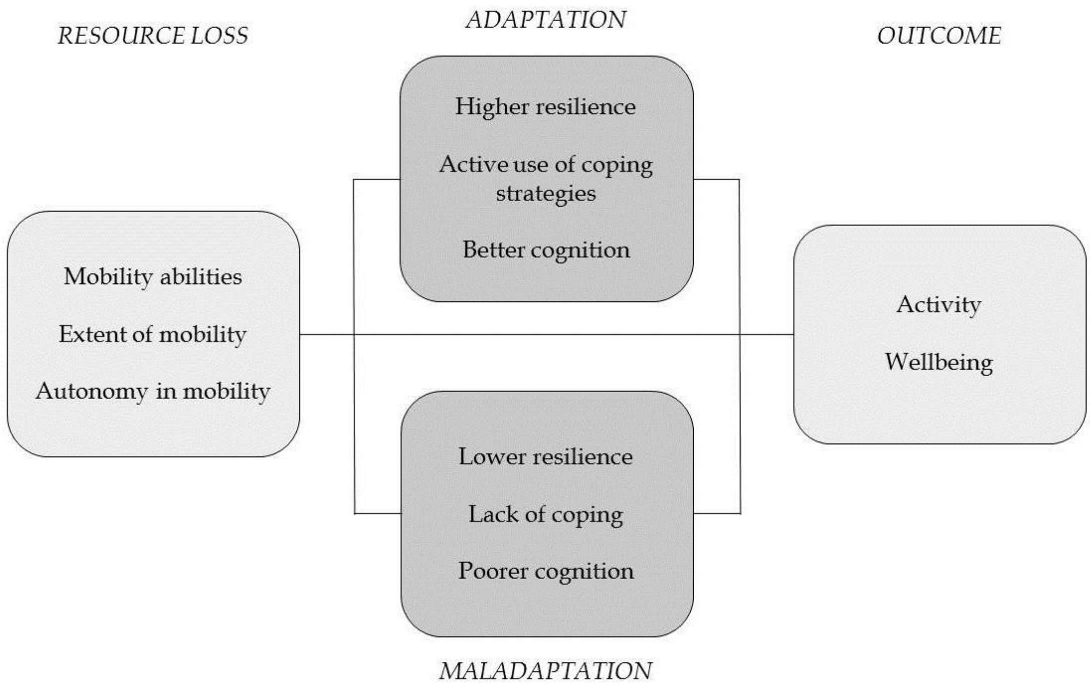

FIGURE 4 Conceptual framework of the study. The core idea is that psychological resources may help older people to adapt to mobility decline and thus help them to maintain a greater level of activity and wellbeing. Conversely, lack or ineffective utilization of psychological resources may predispose to lower activity levels and poorer wellbeing when combined with deficits in mobility.

This study comprises four sub-studies. Although the conceptual framework describes a hypothesized process, it should be noted that two of the sub-studies were cross-sectional. Hence, temporal associations and effects with precursors and outcomes could only be ascertained in two sub-studies, while the other two sub-studies focused on establishing whether, in the first place, a statistically significant association existed between mobility decline, psychological resources, and activity.

3 AIMS OF THE STUDY

The purpose of this study was to discover how cognitive function, coping and resilience as psychological resources modify the associations between mobility decline and activity among community-dwelling older people. A further objective was to investigate whether an individualized active aging counseling intervention affects different perspectives of mobility, physical activity and/or psychological resilience. The specific research questions were:

1. Do cognitive function and physical performance have combined associations with prevalent walking modifications and walking difficulties, and with incidence of walking difficulty over a two-year follow-up among older people? (Study I)

2. How are assimilative and accommodative coping associated with life-space mobility and perceived autonomy in outdoor mobility in old age? (Study II)

3. How are walking difficulties and resilience associated with active aging? Does resilience moderate the relationship between walking difficulties and active aging? (Study III)

4. How does a one-year individualized active aging counseling intervention influence mobility, physical activity, and resilience among older people? (Study IV)

The analytical framework of the study is presented in Figure 5. The associations between psychological resources, mobility decline, and activity were examined with cross-sectional (Studies I, II and III), longitudinal (Study I), and experimental study designs (Study IV).

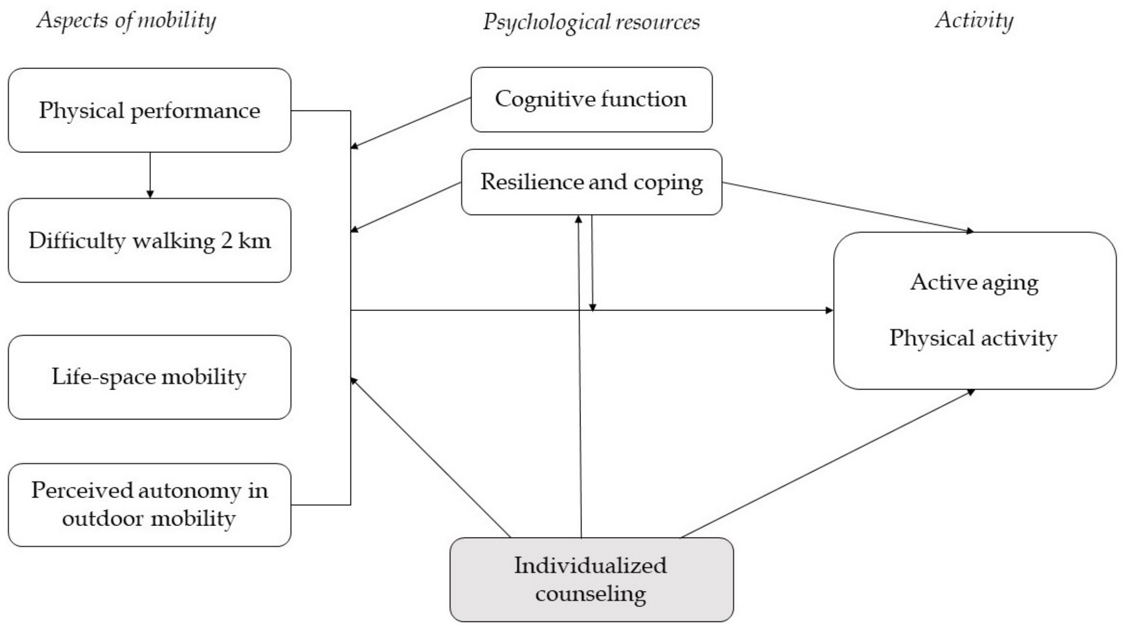

FIGURE 5 Analytical framework of the study. Arrows indicate the associations hypothesized and studied.

4 METHODS

4.1 Datasets and study designs

This study utilized data from two larger research projects: Life-Space Mobility in Old Age (LISPE) and Active Ageing – Resilience and External Support as Modifiers of the Disablement Outcome (AGNES). These cohort study projects also comprised sub-studies, which were utilized here. The Life-Space Mobility and Active Ageing (MIIA) study was conducted with some of the original LISPE participants two years after LISPE, while some of the AGNES cohort study participants were invited to participate in an additional intervention study. The datasets, study designs, and participants are summarized in Table 2.

TABLE 2 Summary of the datasets, study designs and participants.

Study	Dataset	Design	Duration	n	Age, years (M±SD or %)
I	LISPE	Observational, longitudinal	2-year follow-up	Baseline n=848 Follow-up n=761	82.6 ± 4.2
II	MIIA	Observational, cross-sectional		206	84.0 ± 4.1
III	AGNES cohort	Observational, cross-sectional		1021	75yrs, 45% 80yrs, 33% 85yrs, 22%
IV	AGNES intervention	Experimental, randomized controlled trial	1-year intervention	204 Intervention n=101 Control n=103	75yrs, 75% 80yrs, 26%

Note. M = mean, SD = standard deviation, yrs = years

4.1.1 Life-Space Mobility in Old Age (LISPE & MIIA; Studies I & II)

Life-Space Mobility in Old Age (LISPE; Study I)
LISPE was a 2-year prospective cohort study conducted between the years 2012 and 2014 (Rantanen et al. 2012). The study targeted community-dwelling older persons aged 75 to 90 living in the municipalities of Jyväskylä and Muurame in Central Finland. A random sample of 2 550 persons was drawn from the national population register. Of these, 2 269 were reached. To be included in the study, persons had to be willing to participate, live independently in the study area, and able to communicate. Baseline data were available for 848 participants and collected by face-to-face, computer-assisted home interviews.
The first LISPE follow-up was conducted one year after the baseline assessments and included 816 participants. Of these, 761 also participated in the two-year follow-up. Reasons for dropping out during the two-year follow-up were death (n=41), institutionalization (n=15), impaired ability to communicate (n=12), relocating outside the study area (n=6), impaired health (n=5), unwillingness to continue (n=6), and being out of reach (n=2) (Rantakokko et al. 2016). The follow-up data were collected by phone interviews. Participants for whom data on physical performance, cognitive function and walking ability were available, were included in the cross-sectional analyses of Study I (n=827 at baseline). Those who reported no walking difficulties at baseline were also included in the longitudinal analyses (n=492).

Life-Space Mobility and Active Ageing (MIIA; Study II)
MIIA was a cohort study conducted in 2016 and represented a third wave follow-up of the LISPE study. Thus, the MIIA participants were recruited from among the 848 LISPE participants. The MIIA sample was planned to comprise only part of the original sample as, according to power calculations made for the primary outcomes (e.g. life-space mobility), a sample size of 200 was sufficient for moderate correlations to become statistically significant. All those who had taken part in some additional assessments of hearing, vision, and cognition at the second LISPE follow-up were contacted. Since not all of these participants were any longer eligible, an additional sample of 150 participants from the baseline cohort was randomly drawn to obtain the target sample size. The MIIA subsample finally consisted of 298 persons. Of these, 77 declined to participate and 15 were not reached. Hence, data were collected from 206 community-dwelling persons who were aged 79 to 93. Data were collected by face-to-face home interviews.

When comparing the 206 persons who took part in both LISPE and MIIA with the 642 persons who only took part in LISPE, those who participated in both studies were a little younger and had slightly better cognition and physical performance. No differences were found in the amount of males and females, number of chronic conditions, or length of education.

The MIIA data were utilized in Study II. The participants were 186 persons who had answered the questions on TGP, FGA, life-space mobility, and perceived autonomy in participation outdoors. Longitudinal analyses were not possible, as TGP and FGA data were obtained only in this third follow-up wave.

4.1.2 Active aging – Resilience and External Support as Modifiers of the Disablement Outcome (AGNES; Studies III and IV)

AGNES was a large population-based research project conducted between the years 2017 and 2019. AGNES consisted of an observational study for cross-sectional analyses and an experimental, randomized controlled trial for causal analyses.

AGNES cohort (Study III)
The AGNES cohort study targeted 75-, 80- and 85-year-old persons living independently in Jyväskylä, Finland (Rantanen et al. 2018). A total population sample of 2 791 community-dwelling persons was drawn from the national population register. Of these, 2 348 were reached and informed about the study. In addition to age and residence in the study area, other inclusion criteria were willingness to participate and being able to communicate. In total, 1 021 persons participated in the study (Portegijs et al. 2019). Data for Study III were gathered between 2017 and 2018 by computer-assisted, face-to-face interviews in the participant's home. A total of 961 participants had valid data on active aging, walking ability, and psychological resilience and thus were included in the cross-sectional analyses of Study III.

AGNES intervention (Study IV)
The AGNES intervention study was a single-blinded two-arm randomized controlled trial designed to promote active aging, i.e. activity that corresponds to the individual's goals, capacities and opportunities and may engender greater wellbeing (trial register number: ISRCTN16172390). As with the AGNES cohort, the trial targeted community-dwelling older people living in the Jyväskylä area. The intervention lasted for 12 months. According to power calculations made for the primary outcome (active aging), a sample of 168 persons was needed for a 90% probability of detecting a statistically significant treatment difference. However, as the participants were older people and thus potentially vulnerable, and as the intervention was long, a sample of 200 participants was calculated to be sufficient to allow for an attrition rate of 20% during the trial (Rantanen et al. 2019b).

The recruitment process and study flow are described in Figure 6. Participants were recruited from among the participants of the AGNES cohort. Inclusion criteria for the trial were age 75 or 80, consent to future study requests, moderate life-space mobility (score between 52.3 and 90.0 on the Life-Space Assessment), and adequate cognitive function (minimal score of 25 on the MMSE) (Rantanen et al. 2019b). An exclusion criterion was participation in another ongoing intervention study. All eligible AGNES cohort participants were invited to participate in the trial. The 204 persons who gave their verbal consent were randomized either into the intervention group (IG, n=101) or the control group (CG, n=103). In total, 17 participants (8%, n = 10 in IG, n = 7 in CG) dropped out from the study during the 12-month trial. Reasons for dropping out were not willing to continue (65%, n=7 in IG, n=4 in CG), decline in health (11%, n=2 in CG), and death (6%, n=1 in CG). In addition, one IG participant's data were damaged at the 12-month follow-up. Data utilized in Study IV were collected pre-trial (at baseline before randomization) and post-trial (at 12-month follow-up) with computer-assisted home-interviews and thigh-worn accelerometers in the free-living environment. The interviewers were blinded to the treatment-group allocation.

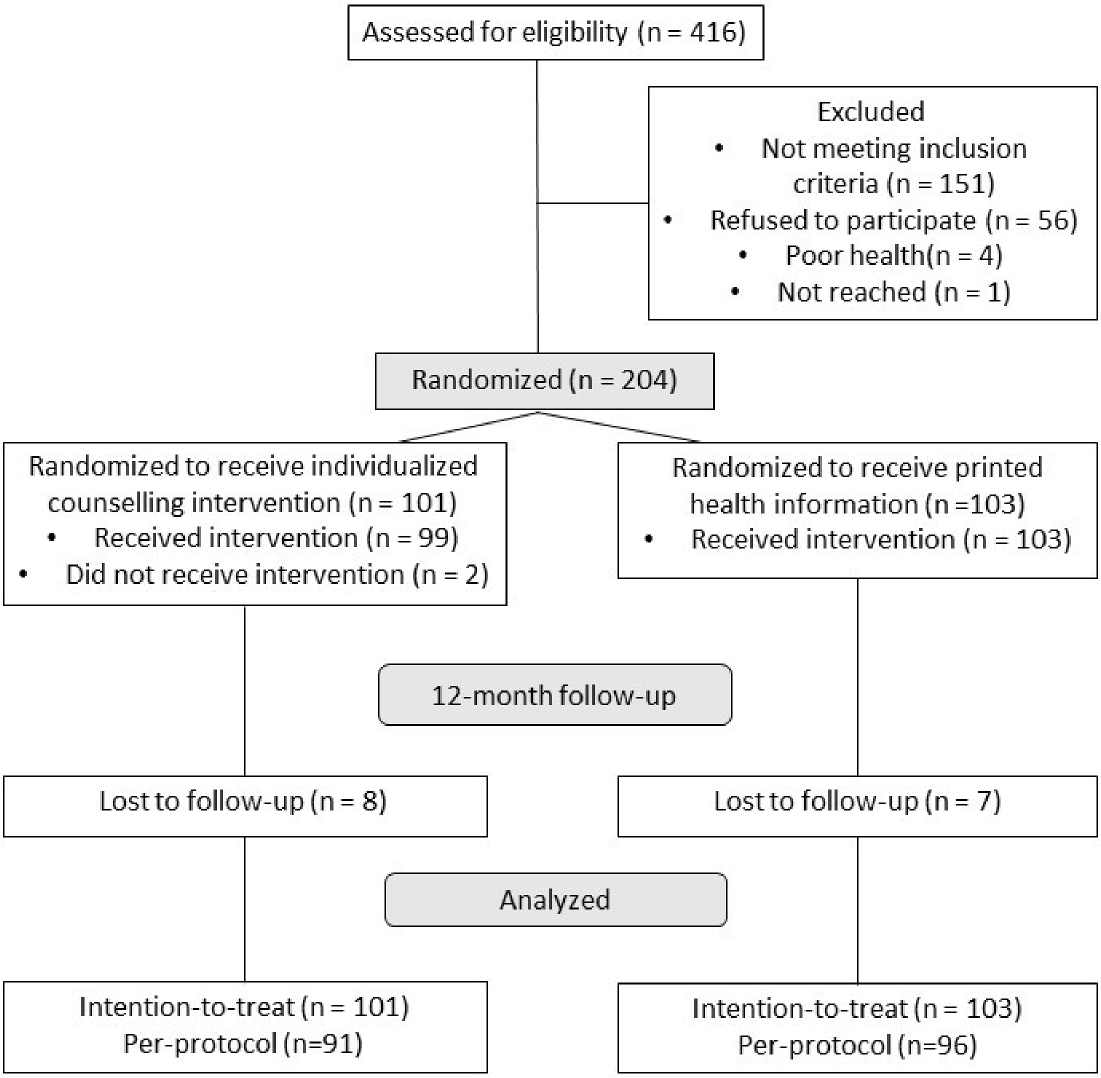

FIGURE 6 Flow chart of the AGNES intervention study (Study IV, adapted from Rantanen et al. 2020).

The intervention group received counseling related to increasing their activity in self-selected, preferably out-of-home and social activities. The aim was to help participants to set new goals related to self-selected activities, support their autonomous motivation and, eventually, induce positive changes in the amount of activity. The first 90 min counseling session was held face-to-face in the research center and followed a semi-structured protocol. During the session, participants were provided with support material: an information booklet on active aging, a calendar, and a newsletter featuring different activities organized for older people in the study area and success stories about other participants' active lives. The newsletter was updated and sent to the participants three additional times during the 12 months. In addition to the face-to-face session, participants received four phone counseling sessions that were conducted at 1, 3, 6 and 9 months after the baseline. The control group received printed general health information by post. The general health information materials were divided into four themes: 1) exercise, 2) nutrition, 3) cardiovascular diseases, and 4) type II diabetes and mailed to the participants at 1, 3, 6, and 9 months after the baseline. In addition, when the trial ended, controls received the same active aging information booklet and were thus exposed to the same active aging information as those in the intervention group.

4.2 Ethics

All studies were conducted following the principles of good scientific practice laid down by the Declaration of Helsinki. Participation was voluntary and participants had the right to withdraw from the study at any point. In addition, participants were informed about the studies and gave their written informed consents before the assessments. The LISPE and MIIA studies were approved by the ethical committee of the University of Jyväskylä, Finland, and the AGNES project was approved by the ethical committee of the Central Finland Hospital District. All digital data gathered for all the studies were stored and treated confidentially on the university server and protected by passwords to which only the members of the research teams had access. The data were pseudonymized for analyses.

4.3 Measurements

4.3.1 Active aging

Active aging was assessed with the University of Jyvaskyla Active Ageing Scale (UJACAS), which comprises 17 items on social, cultural, cognitive, and physical activities (Rantanen et al. 2019a). The activities include practicing memory, using a computer, exercising, taking care of appearance, making the home cozy and pleasant, helping others, maintaining friendships, balancing personal economics, and participating in events. Each item is assessed on four aspects: goals (whether the persons wants to do it), functional capacity (is the person able to do it), autonomy (does the person perceive opportunities to do it), and amount of activity (how often or how much the person does it). Participants are instructed to look back over the past four weeks when answering the items. Responses are given on a five-point Likert-type scale ranging from 0 (lowest) to 4 (highest). For the present study, a total score was calculated by summing the scores of the individual items of each aspect (range 0-272 with higher scores indicating more active aging). A maximum of two items in each aspect was allowed to be missing. To correct for missing items, the following formula was used: (sum score / items responded to) x items offered. The validity and reliability of the measure have been established (Rantanen et al. 2019a). The UJACAS was used in the analyses of Study III.

4.3.2 Life-space mobility

Life-space mobility was assessed with the Finnish version (Portegijs et al. 2014b) of the University of Alabama at Birmingham Study of Aging Life-Space Assessment (Baker et al. 2003). The scale encompasses six life-space areas: bedroom, other rooms at home, yard, neighborhood, town, and beyond town. Participants are asked whether they have been to these areas, and if so, how often, and whether they have needed assistance (device or another person) in doing so. The responses are based on the four weeks preceding the assessment. For the present study, we used a composite score reflecting the distance, frequency, and level of independence of mobility. The composite score was first computed for each level as follows: level score x frequency score x assistance score, after which the level scores were summed. The score ranged between 0 and 120 with higher scores indicating greater life-space mobility. The Life-Space Assessment (LSA) has found to be valid and reliable (Allman et al. 2006; Portegijs et al. 2014b). Life-space mobility was used as an outcome in Studies II and IV.

4.3.3 Perceived autonomy in outdoor mobility

Perceived autonomy in outdoor mobility was assessed with the "autonomy outdoors" subscale of the Impact on Participation and Autonomy (IPA) questionnaire (Cardol et al. 2001). The subscale contains five items assessing self-rated possibilities to 1) visit relatives and friends, 2) make trips and travel, 3) spend leisure time, 4) meet other people, and 5) live life as one wants. Responses are given on a five-point Likert scale ranging from very good (0) to very poor (4). A sum score (range 0-20) with higher scores indicating poorer autonomy was calculated for Studies II and IV. The IPA questionnaire is a validated measure that can be utilized as a whole or as subscales (Cardol et al. 2001; Kersten et al. 2007).

4.3.4 Walking difficulties

Walking difficulties over a 2 km distance were assessed with validated self-reports (Mänty et al. 2007) in Studies I, III and IV. Participants were asked if they were able to walk 2 km, and the response options were "able without difficulty", "able with some difficulty", "able with a great deal of difficulty", "unable without the help of another person", and "unable to manage even with help". In Studies I and IV, the variable was dichotomized into those reporting no difficulty and to those reporting (at least some) difficulty walking 2 km. In Study III, the walking difficulty variable was categorized into three according to the degree of difficulty. The categories were: 1) no difficulty, 2) some or a great deal of difficulty, and 3) unable to walk without or with assistance. In addition, in Study I, those who reported no difficulties in walking were additionally asked whether they had modified their way of walking. Participants answered yes or no to the following modification items: decreased walking frequency, given up walking the distance, use of an assistive device, slower walking pace, and pausing for rest during the performance. Those who reported noticing at least one of these changes were classified as having walking modifications and formed a third category in between those with no difficulties and those having at least some difficulty. In all studies, those reporting no difficulty (and no modifications) served as the reference category.

4.3.5 Physical performance

Physical performance was assessed with the Short Physical Performance Battery (SPPB) indicating lower extremity performance (Guralnik et al. 1994). The test contains three sub tests measuring standing balance (feet together, semi-tandem, and full tandem), walking speed (normal speed for 2.44 m in Studies I and II or 3 m in Study IV), and chair rise (5 times). Each sub test is scored from 0 (lowest) to 4 (highest). A sum score (range 0-12 with higher scores indicating better performance) was calculated when at least two of the three tests were completed (Portegijs et al. 2014a). To correct for the missing test, the sum scores were multiplied by the maximum possible test score (12) and then divided by the maximum possible performed test score (8). In Study I, physical performance was the independent variable and classified as good (≥10) or impaired (<10). In Study II, physical performance was a covariate, and used as a continuous variable. In Study IV, physical performance was a continuous outcome variable.

4.3.6 Physical activity

Physical activity was an outcome in Study IV and assessed both subjectively and objectively. *Self-reported physical activity* was assessed with the second part of the Yale Physical Activity Survey (YPAS), which includes questions for 1) vigorous activity, 2) walking, 3) general moving, 4) standing, and 5) sitting (Dipietro et al. 1993). In this survey, participants are asked how often and for how long at a time they have engaged in each of the five activities during the past month. The frequency and duration scores are multiplied and weighted based on the relative intensity of the activity to form a Total Activity Summary Index (range 0-137). Higher scores indicate greater physical activity. The scale is moderately valid and reliable in older populations (Schuler et al. 2001). In Study IV, one participant had neither pre-trial nor post-trial data and was therefore excluded from the analysis. *Objectively monitored physical activity* was recorded using tri-axial accelerometers (13-bit ±16 g, UKK RM42, UKK Terveyspalvelut Oy, Tampere, Finland) in the free-living environment. Participants were asked to wear the monitors for 7 to 10 days pre-trial and for 6 days post-trial immediately following the home-interview. Only those willing to participate in the pre-trial monitoring were invited to wear the monitors during the post-trial period. The accelerometer was attached to the participant's dominant thigh (i.e., the kicking leg) with self-adhesive film. The film was waterproof but longer water-related activities, e.g. swimming, bathing, sauna, were not recommended while wearing the accelerometer. Mean 24h acceleration (measured in milligravity units, mg) was used as an indicator of physical activity (Rowlands 2018), since it can summarize both the intensity and duration of activity into a single measure without threshold values and provides directly comparable data in the same wear location. Average acceleration was computed as the mean high-pass filtered vector magnitude of non-overlapping five-second epochs (Van Hees et al. 2013). Three full days of data were required.

4.3.7 Psychological resilience

In Study III, resilience was assessed with the 10-item shortened version of the Connor-Davidson Resilience Scale (CD-RISC10) (Connor & Davidson 2003; Campbell-Sills & Stein 2007). Items such as "can deal with whatever comes", "can achieve goals despite obstacles", and "not easily discouraged by failure" reflect an individual's ability to positively adapt to a variety of life hazards. The response options for the ten items range from not true at all (0) to true nearly all the time (4). A sum score (range 0-40, higher scores indicating greater resilience) was computed when responses were given to at least seven items. Individual missing items were imputed for 12 persons. The CD-RISC is one of the most highly recommended tools for assessing resilience (MacLeod et al. 2016), and its psychometric properties have proven to be relatively good in the AGNES sample (Tourunen et al. 2019).

4.3.8 Coping

Tenacious goal pursuit (TGP) and flexible goal adjustment (FGA), two distinct coping strategies, were assessed with separate scales (Brandtstädter & Renner 1990). The TGP scale reflects the tendency to persistently pursue personal goals even in the face of obstacles or failure, while the FGA scale reflects the ability to adjust one's goals to changed life circumstances by downgrading the importance of certain goals or by abandoning blocked goals. In Study II, we used the shortened versions of the scales (Kelly et al. 2013). The shortened scales each contain five items, such as “Even when things seem hopeless, I keep on fighting to reach my goals” (TGP) and “If I do not get something I want, I take it with patience” (FGA). Participants rate their agreement on a five-point Likert scale from strongly agree (1) to strongly disagree (5). Both scales include one inversely phrased item. For the analyses of Study II, we omitted the inversely phrased items, as they correlated poorly with the other items (TGP: r = .20-.18, FGA: r = .09-.21). In addition, both scales showed better internal validity without the inversely phrased items (TGP: Cronbach’s α=.72 with and .77 without the reversed item; FGA: Cronbach’s α=.60 with and .67 without the reversed item). The remaining four items in each scale were reverse scored, with higher scores indicating greater tenacity or flexibility in goal pursuit (range 0-16), and summed when responses were given for at least three of the four items. Missing items were imputed with the mean of the participant’s three existing values.

4.3.9 Cognitive function

Cognitive function was assessed with the Mini Mental State Examination (MMSE), which can identify persons with impairments in global cognitive function (Folstein et al. 1975). The examination consists of items reflecting orientation, registration, attention, calculation, recall, and language. A sum score (range 0-30, higher scores indicating better performance) was calculated, and scaled in case the respondent was not able to complete all the tasks, e.g., due to visual impairment. In Study I, the variable was dichotomized into intact cognition (≥24) and declined cognition (<24). In Studies II and III, cognitive function was a covariate and treated as continuous.

4.3.10 Covariates and descriptive variables

For all studies, age and sex were drawn from the Finnish National Population Register. Length of education was used as an indicator of socio-economic status and in Studies I-III, ascertained with one question: “How many years of education have you had in total?” In study IV, participants were asked about their highest level of education. The answers were categorized into three levels: high (high school diploma or university degree), intermediate (middle school, folk high school, vocational school or secondary school), and low (primary school or less). Morbidity, indicated as self-reported physician diagnosed number of chronic conditions, was calculated based on a list of 22 conditions and an open-ended additional question in Studies I & II. In Study III, a similar list was used but it included 34 common conditions. In Study IV, health was self-reported and the response options ranged from very good to very poor. The variable was categorized into good or very good health vs. moderate or poorer health. Depressive symptoms were measured with the 20-item Center for Epidemiologic Studies Depression Scale (CES-D, Studies I & II) (Radloff 1977). Vision was self-reported and assessed with the question: “How well can you see from a distance?” The responses were categorized into good (those who answered “well” or “reasonably well”) and declined (those who answered “poorly”; Study I).

Living situation was ascertained with one question: “Who do you live with?” The response options were “alone”, “with a spouse”, “with children or grandchildren”, or “with relatives, siblings, or other people”. Respondents were classified into those living alone and to those living with someone (Studies III and IV). Marital status was categorized as “married” or “not married” (Study IV). Environmental barriers at entrances and in close exterior surroundings were recorded at the participants' home with the Housing Enabler screening tool (Iwarsson et al. 2012). These covariates were chosen based on their correlations with at least one of the predictors and the outcome of interest. In Study IV, variables were used only to describe the background characteristics of the participants.

All study variables are summarized in Table 3.

TABLE 3 Summary of the study variables.

Variable	Study	Methods and reference
Activity		
Active aging	III	University of Jyvaskyla Active Ageing Scale, UJACAS (Rantanen et al. 2019a)
Physical activity	IV	
Self-reported		Yale Physical Activity Survey, YPAS (Dipietro et al. 1993)
Monitored		UKK RM42 tri-axial accelerometers (Portegijs et al. 2019)
Mobility		
Walking difficulty	I, III, IV	Self-reported (Mänty et al. 2007)
Physical performance	I, II, IV	Short Physical Performance Battery, SPPB (Guralnik et al. 1994)
Life-space mobility	II & IV	The Life-Space Assessment (Baker et al. 2003)
Perceived autonomy in participation outdoors	II & IV	Impact on Participation and Autonomy, IPA, outdoors subscale (Cardol et al. 2001)
Psychological resources		
Cognitive function	I-III	Mini Mental State Examination, MMSE (Folstein et al. 1975)
Coping	II	Tenacious Goal Pursuit and Flexible Goal Adjustment Scales (Brandtstädter & Renner 1990; Kelly et al. 2013)
Resilience	III	10-item Connor-Davidson Resilience Scale, CD-RISC10 (Connor & Davidson 2003; Campbell-Sills & Stein 2007)
Covariates and descriptive variables		
Age, years	I-IV	Finnish national population register
Sex	I-IV	Finnish national population register
Education	I-IV	Years or highest level, self-reported (Pohjolainen et al. 1997)
Number of chronic conditions	I-II	Self-reported
Perceived overall health	III-IV	Self-reported
Living alone	III-IV	Self-reported
Marital status	IV	Self-reported
Depressive symptoms	I & II	Center for Epidemiologic Studies Depression Scale, CES-D (Radloff 1977)
Vision	I	Self-reported
Entrance related environmental barriers	II	Housing Enabler screening tool (Iwarsson et al. 2012)

4.4 Statistical analyses

All statistical analyses, except for the mediation analysis in Study I, were conducted with the Statistical Package for Social Sciences (SPSS) version 24.0 for

Windows. In addition, PROCESS macro version 3 for SPSS (Hayes 2017) was used in Study III for the moderation analyses. For the mediation analysis in Study I, we used Mplus version 5.21 (Muthén & Muthén 2017). Significance level was set at $p<.05$ in all analyses.

Descriptive statistical analyses

Descriptive statistics were reported as means and standard deviations for continuous variables and as frequency percentages for categorical variables. One-way analysis of variance (ANOVA) and the Bonferroni post hoc test were used to compare means between three or more groups, and chi-square test to compare frequencies and proportions between different groups.

Creating profiles

In Study I, the combined associations of physical performance and cognitive function with walking difficulty were investigated by using established cut-off values for physical and cognitive function and creating different combinations of these categories of functioning. The following four categories were created: 1) good physical performance (SPPB ≥10) and good cognitive function (MMSE ≥24), 2) good physical performance and poor cognitive function (MMSE <24), 3) impaired physical function (SPPB <10) and good cognitive function, and 4) impaired physical function and poor cognitive function. The first category was used as reference.

In Study II, to identify the different coping profiles and to investigate the combined associations of tenacious goal pursuit (TGP) and flexible goal adjustment (FGA) with out-of-home mobility, a two-step cluster analysis was conducted. Two-step clustering identifies groupings or profiles by first running pre-clustering, and then running hierarchical methods. Two-step clustering was executed with log-likelihood as a distance measure and without determining the number of clusters beforehand. To ensure the stability of the given cluster solution, the analysis was performed five times with different randomized orders of the cases.

Regression analyses

In Study I, multinomial logistic models were used to examine the cross-sectional associations of physical performance and cognitive function with walking ability. The base model was adjusted for age and sex, and the second model additionally for years of education, number of chronic conditions, depressive symptoms, and vision. The model with only cognitive function as an independent variable was additionally adjusted for physical performance, and vice versa.

Cox regression was used in Study I to examine whether physical performance and cognition separately or together predicted the incidence of walking difficulty over a 2-year period. The analysis was conducted among participants who did not report walking difficulties (regardless of walking modifications) at baseline (n=492). Participants were censored either at the time they reported walking difficulty or at the end of the follow-up, whichever happened first. Those who had missing data on walking ability at the one-year or at the two-year follow-up were censored at the time they had a valid answer. The analysis was first performed among all participants without walking difficulty at baseline. Thereafter, the analysis was stratified according to walking modifications. The same adjustments were made for the Cox regression models as for the multinomial regression models.

Ordinary least squares (OLS) regression analysis, which is a form of linear regression, was utilized in Study III to investigate the associations of resilience and walking difficulties with active aging. The trichotomous walking difficulty variable was coded as multicategorical using the indicator, i.e., dummy, method. First, resilience and walking difficulties were set as independent variables in separate models, and subsequently, in the same model. These preliminary models were unadjusted.

General linear models

In Study II, general linear models (GLM) were used to estimate life-space mobility and perceived autonomy in participation outdoors for different psychological coping profiles. Marginal means and their standard errors were represented for the reference category, and unstandardized coefficients (B) with 95% confidence intervals for the other categories. The base model was adjusted for age and sex. In the second step, the models were additionally adjusted for physical performance, cognitive function, environmental barriers, and depressive symptoms one at a time to determine whether some of these factors influenced the associations.

Mediation and moderation analyses

A latent factor mediator analysis was used in Study I to assess whether physical performance mediated the association between cognitive function and walking ability at baseline. The indirect and direct effects were described with unstandardized path coefficients and their 95% confidence intervals. The mediator model was adjusted for age and sex.

In Study III, an OLS regression path analysis, in which resilience was set as a moderator of the association between walking difficulties and active aging, was conducted. In this moderator model, resilience and walking difficulties were allowed to interact. The walking difficulty variable was trichotomous, and therefore needed to be coded as multicategorical using the indicator, i.e., dummy, method. The moderation effect was probed using the pick-a-point approach by regression centering, with the 16th, 50th, and 84th percentiles of the resilience scale distribution describing relatively low, moderate, and high values (Hayes 2017). The analysis was stratified by age group. The models were first unadjusted, after which age, sex, number of chronic conditions, years of education, living alone, and cognitive function were added one at a time. Finally, all the covariates were added to the model simultaneously.

Intervention effects

To investigate whether the active aging counseling intervention had positive effects on the pre-planned secondary mobility, physical activity and resilience outcomes in Study IV, general estimating equation (GEE) analyses were performed. The specific outcomes in these analyses were physical performance, self-reported difficulties in walking 2 km, life-space mobility, perceived autonomy in outdoor mobility, self-reported and monitored physical activity (reported in the original paper of Study IV), and resilience (reported in this dissertation only). The advantages of GEE analysis are that it does not assume that the studied variables are normally distributed (Liang & Zeger 1986) and that it also utilizes information from incomplete pair of observations, i.e. includes in the analyses participants who may have missing information at some assessment points (Zhang et al. 2014). Continuous outcomes were analyzed with linear models and the binary walking difficulty outcome with binary logistic models with an unstructured working correlation matrix. We tested the main effects of group and time, and also the group by time interactions. All outcomes were analyzed in separate models.

If a statistically significant group by time effect was detected, we calculated a change score for the outcome by subtracting the baseline score from the follow-up score. For the change scores, we calculated Cohen's effect sizes and their 95% confidence intervals. Further, we translated the change scores into relative improvement scores (percentual change to positive) and tested between-group differences with independent samples t-test and within-group differences with paired sample t-test.

Missing data

Overall, the amount of missing data in all the datasets used in the current research was small. However, some statistical operations were performed to maximize statistical power and to analyze study attrition. In Study I, we performed a Little's MCAR test to investigate study attrition during the two-year follow-up. The results showed that missing data at follow-up were not missing completely at random ($\chi^2 = 9.76$, df = 1, p = .002). Thus, we assumed that those who reported no walking difficulties at baseline but dropped out during the follow-up due to death or institutionalization (n=22), would have shown a decline in mobility at follow-up. We used this information to execute a sensitivity analysis and repeated the Cox regression analysis, categorizing these 22 persons as having developed walking difficulty.

In Study II, to maximize the available data on TGP and FGA, we imputed single missing items for participants who had responded to three of the four items on the TGP (n=3, 1.4%) and FGA (n=3, 1.4%) scales. In Studies III and IV, missing items for resilience were imputed when values were available for at least seven of the ten items on the CD-RISC10 resilience scale. For perceived autonomy in outdoor mobility (IPA outdoors), only one missing item was allowed (Study IV). All imputations were based on the participant's mean values on the respective measure (at the same time point).

5 RESULTS

5.1 Participant characteristics

The baseline characteristics of the study participants in the LISPE (Study I), MI-IA (Study II), AGNES cohort (Study III) and AGNES intervention (Study III) studies are summarized in Table 4. In the AGNES cohort study (Study III), 46% of the participants were aged 75, 33% aged 80, and 21% aged 85. In the AGNES intervention study (Study IV) 75% of the participants were aged 75 and 26% aged 80.

TABLE 4 Baseline characteristics of the study participants in the different datasets.

Characteristics	Study I n=848	Study II n=206	Study III n=1018	Study IV n=204
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Age (years)	80.6 ± 4.2	84.0 ± 4.1	-	-
Education (years)	9.6 ± 4.1	9.8 ± 4.3	11.6 ± 4.6	11.7 ± 3.8
Number of chronic conditions	4.4 ± 2.4	4.4 ± 2.5	3.4 ± 2.0	-
Depressive symptoms (CES-D)	9.6 ± 6.8	9.5 ± 7.1	8.6 ± 7.1	7.6 ± 6.6
Cognitive function (MMSE)	26.2 ± 2.8	26.1 ± 2.9	27.1 ± 2.6	28.0 ± 1.4
Physical performance (SPPB)	9.6 ± 2.5	9.0 ± 2.4	9.9 ± 2.3	10.8 ± 1.4
Life-space mobility (LSA)	63.9 ± 20.6	60.2 ± 21.5	71.2 ± 18.9	74.6 ± 9.3
Perceived autonomy (IPA)	6.2 ± 3.8	6.5 ± 4.0	-	4.5 ± 3.3
Number of environmental barriers	-	11.2 ± 3.8	-	-
Resilience (CD-RISC10)	-	-	31.1 ± 5.2	31.7 ± 5.0
Active aging (UJACAS)	-	-	193.3 ±32.0	206.0 ± 25.8
	%	%	%	%
Women	62.0	56.3	57.3	60.8
Difficulties walking 2 km	42.0	42.7	36.2	17.3
Poor vision	3.8	2.0	-	-
Living alone	53.4	58.7	41.0	34.3
Good perceived health	35.8	37.8	45.6	57.8
Marital status, married	43.3	38.8	55.6	63.5

5.2 Associations between physical performance, cognitive function, and walking difficulties (Study I)

The combined associations of cognitive function and physical performance with 1) perceived walking modifications and walking difficulties over a 2 km distance at baseline, and 2) the incidence of difficulty walking 2 km over a two-year follow-up were investigated in Study I. Furthermore, it was tested in this study whether physical performance mediated the association between cognitive function and perceived walking ability.

At baseline, one-third of the participants (33%, n=280) reported no difficulty walking 2 km, one-fourth (25%, n=212) reported walking modifications, and 42% (n=356) reported at least some difficulty. The multinomial regression analyses revealed that at baseline, poorer physical performance (SPPB<10), was associated with walking modifications and walking difficulties. Poorer cognitive function (MMSE<24) was associated only with walking difficulties. The greatest odds for walking difficulties were observed among those with both poorer physical performance and poorer cognitive function (Table 5). A similar association, although with less pronounced odds, was observed for walking modifications. For example, in the fully adjusted model with participants with intact physical and cognitive function as a reference group, the odds for walking modifications among those with poorer physical performance and poorer cognitive function were 2.65 (95% CI 1.05-6.69), whereas the odds among those with poorer physical performance and good cognitive function were 2.13 (95% CI 1.29–3.51).

TABLE 5 Multinomial regression analyses of the individual and combined associations of physical performance and cognitive function with perceived walking difficulty at baseline (n=827).

	Reporting walking difficulty at baseline		
	Model 1	Model 2	Model 3
	OR (95% CI)	OR (95% CI)	OR (95% CI)
MMSE (<24 vs. ≥24)	1.97 (1.22, 3.17)	2.11 (1.25, 3.57)	1.81 (1.05, 3.14)[a]
SPPB (<10 vs. ≥10)	7.07 (4.71, 10.62)	5.24 (3.39, 8.10)	5.06 (3.26, 7.84)[b]
SPPB ≥10 & MMSE ≥24	1.00 (ref.)	1.00 (ref.)	-
SPPB ≥10 & MMSE <24	1.78 (.95, 3.35)	2.04 (1.03, 4.05)	-
SPPB <10 & MMSE ≥24	7.18 (4.58, 11.25)	5.38 (3.32, 8.73)	-
SPPB <10 & MMSE <10	9.70 (4.30, 21.86)	7.67 (3.27, 18.04)	-

Note. Odds ratios are statistically significant if the null value 1.00 is not included in the confidence intervals. *Model 1* was adjusted for age and sex. *Model 2* was additionally adjusted for years of education, number of chronic conditions, depressive symptoms, and vision. *Model 3* was additionally adjusted for [a] physical performance or [b] cognitive function.

OR = odds ratio, SPPB = Short Physical Performance Battery, MMSE = Mini Mental State Examination

The longitudinal analyses included participants who did not report walking difficulty at baseline (n=492). Of these, 153 (31%) developed walking difficulty during the two-year follow-up. Poorer physical performance, but not poorer cognitive function, at baseline increased the risk of reporting walking difficulty at follow-up (Table 6). When the analysis was stratified by walking modifications at baseline, the results remained parallel, except for those reporting neither walking modifications nor difficulties at baseline. Among these, the highest risk for developing walking difficulty during the follow-up was found for people with both poorer physical performance and poorer cognitive function (HR 2.75, 95% CI 1.01–4.17). Finally, categorizing those who died or were institutionalized during the follow-up as having developed walking difficulty did not markedly alter the main findings (data not shown).

TABLE 6 Baseline physical performance and cognitive function as predictors of incidence of perceived walking difficulty over a two-year follow-up in the Cox regression models (n=492).

	Reporting walking difficulty at follow-up		
	Model 1	Model 2	Model 3
	HR (95% CI)	HR (95% CI)	HR (95% CI)
MMSE (<24 vs. ≥24)	1.28 (.84, 1.95)	1.28 (.83, 1.98)	1.06 (.68, 1.67)[a]
SPPB (<10 vs. ≥10)	1.85 (1.32, 2.60)	1.84 (1.30, 2.60)	1.82 (1.28, 2.59)[b]
SPPB ≥10 & MMSE ≥24	1.00 (ref.)	1.00 (ref.)	-
SPPB ≥10 & MMSE <24	1.47 (.86, 2.52)	1.59 (.92, 2.76)	-
SPPB <10 & MMSE ≥24	2.10 (1.45, 3.06)	2.20 (1.50, 3.22)	-
SPPB <10 & MMSE <10	1.50 (.77, 2.92)	1.38 (.70, 2.71)	-

Note. Hazard ratios are statistically significant if the null value 1.00 is not included in the confidence intervals. *Model 1* was adjusted for age and sex. *Model 2* was additionally adjusted for years of education, number of chronic conditions, depressive symptoms, and vision. *Model 3* was additionally adjusted for [a] physical performance or [b] cognitive function. HR = hazard ratio, SPPB = Short Physical Performance Battery, MMSE = Mini Mental State Examination

In the age- and sex-adjusted latent factor mediator model, the association of better cognitive function with better walking ability at baseline was mediated through better physical performance. In addition, the direct association between cognitive function and perceived walking ability became non-significant when physical performance was included in the model (Figure 7). Longitudinal mediation analyses were non-relevant as cognitive function did not independently predict incident walking difficulty.

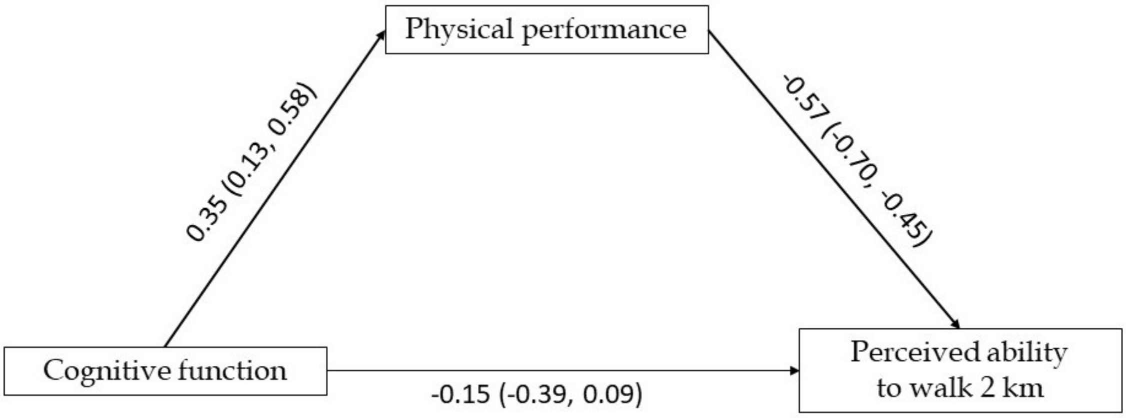

FIGURE 7 Unstandardized path coefficients with 95% confidence intervals of a latent factor mediator model, in which physical performance was set as a mediator of the relationship between cognitive function and perceived ability to walk 2 km (n=827). Path coefficients are statistically significant if zero is not included in the confidence intervals.

5.3 Associations between tenacious goal pursuit, flexible goal adjustment, and out-of-home mobility (Study II)

The aim of Study II was to 1) identify different coping profiles of tenacious goal pursuit (TGP) and flexible goal adjustment (FGA) in a cross-sectional, population-based dataset, and 2) to estimate life-space mobility and perceived autonomy in outdoor mobility in these data-driven coping profiles. Four coping profiles were found: 1) high TGP and high FGA, 2) moderate TGP and low FGA, 3) low TGP and moderate FGA, and 4) low TGP and low FGA. These profiles are presented in more detail in Table 7.

TABLE 7 Data-driven coping profiles described by means of tenacious goal pursuit (TGP, range 0-16) and flexible goal adjustment (FGA, range 0-16) and their standard deviations (SD).

Profile	N (%)	TGP mean ± SD	FGA mean ± SD
High TGP & high FGA	59 (31.7)	14.6 ± 1.1	14.7 ± 1.1
Moderate TGP & low FGA	53 (28.5)	12.9 ± 1.5	10.2 ± 1.7
Low TGP & moderate FGA	49 (26.3)	9.7 ± 1.7	13.4 ± 1.5
Low TGP & low FGA	25 (13.4)	6.5 ± 2.2	9.3 ± 2.6

The general linear models showed that the participants with the profile of high tenacity and flexibility reported the highest and those with the profile of low TGP and FGA the lowest life-space mobility (Table 8). However, when the model was adjusted for either physical or cognitive function, the poorest scores were observed among those with low TGP and moderate FGA while the results for those with low TGP and low FGA became non-significant. Moreover, when the model was adjusted for depressive symptoms, the associations between coping and life-space mobility were attenuated, rendering all the differences between the coping profiles non-significant. On perceived autonomy in outdoor mobility, the poorest scores, including after all adjustments, were found for those with low TGP and low FGA (Table 9). However, the associations between coping and perceived autonomy were also attenuated when depressive symptoms were included in the model.

TABLE 8 Marginal means (MM) and standard errors (SE) of life-space mobility scores (range 0-120, with higher scores indicating larger life-space) and unstandardized regression coefficients (*B*) by coping profile.

General linear models	Coping profile				
	High TGP & high FGA MM (SE)		Moderate TGP & low FGA *B*	Low TGP & moderate FGA *B*	Low TGP & low FGA *B*
Unadjusted	67.6 (2.7)	Ref.	-6.57 *ns*	-10.38	-13.91
Age and sex	66.9 (2.4)	Ref.	-6.95	-9.04	-10.35
+ SPPB	65.7 (1.9)	Ref	-4.52 *ns*	-6.47	-5.77 *ns*
+ entrance barriers	67.6 (2.5)	Ref.	-7.98	-10.20	-10.68
+ MMSE	66.5 (2.3)	Ref.	-6.86	-9.19	-7.43 *ns*
+ CES-D	64.9 (2.3)	Ref.	-3.48 *ns*	-6.41 *ns*	-6.69 *ns*

Note. Statistical significance of all the coefficients in the table was $p < .05$, unless marked otherwise. *ns* = non-significant
SPPB = Short Physical Performance Battery, MMSE = Mini Mental State Examination,
CES-D = Centre for Epidemiologic Studies Depression Scale

TABLE 9 Marginal means (MM) and standard errors (SE) of perceived autonomy in participation outdoors scores (range 0-20, with higher scores indicating poorer autonomy) and unstandardized regression coefficients (*B*) by coping profile.

General linear models	Coping profile				
	High TGP & high FGA MM (SE)		Moderate TGP & low FGA *B*	Low TGP & moderate FGA *B*	Low TGP & low FGA *B*
Unadjusted	4.4 (0.5)	Ref.	2.82	3.11	3.87
Age and sex	4.5 (0.5)	Ref.	2.87	2.96	3.50
+ SPPB	4.7 (0.4)	Ref	2.58	2.59	2.86
+ entrance barriers	4.5 (0.5)	Ref.	2.90	2.96	3.38
+ MMSE	4.5 (0.5)	Ref.	2.87	2.98	3.31
+ CES-D	5.4 (0.4)	Ref.	1.50*	1.74*	1.77*

Note. Statistical significance of all the coefficients in the table was $p < .001$, unless marked otherwise. * $p < .05$
SPPB = Short Physical Performance Battery, MMSE = Mini Mental State Examination, CES-D = Centre for Epidemiologic Studies Depression Scale

5.4 Psychological resilience as a modifier of the relationship between walking difficulties and active aging (Study III)

Study III investigated whether psychological resilience moderated the association between walking difficulties and active aging. It was hypothesized that while high levels of resilience may alleviate the negative effects of walking difficulties on active aging, such alleviation might be dependent on the degree of the walking difficulty and/or on age group. Participants were 75, 80, and 85 years old. The 85-year-olds scored lower on the active aging scale than the 75- or 80-year-olds (UJACAS mean 177.4 vs. 200.5 and 194.0, respectively, p<.001) and a greater proportion of them reported walking difficulties or inability to walk 2 km (54.5% vs. 26.4% and 37.5%, respectively, p<.001). However, there were no significant differences in resilience scores between the three age groups.

As expected, reporting walking difficulties or inability to walk 2 km were associated with lower active aging scores in all age groups. Further analysis showed that resilience moderated the relationship between walking difficulties and active aging across the study population (Figure 8) and separately among the 75- and 80-year-olds, such that higher resilience was associated with higher active aging scores among both those not reporting and those reporting difficulty walking 2 km. However, among those reporting inability to walk 2 km, high resilience was not associated with higher active aging scores. The moderation effect was significant at all three probed levels of resilience (relatively low, moderate, and relatively high resilience, $p < .001$ for all). Among the 85-year-olds, the moderation effect of resilience did not reach statistical significance, even for the unadjusted model.

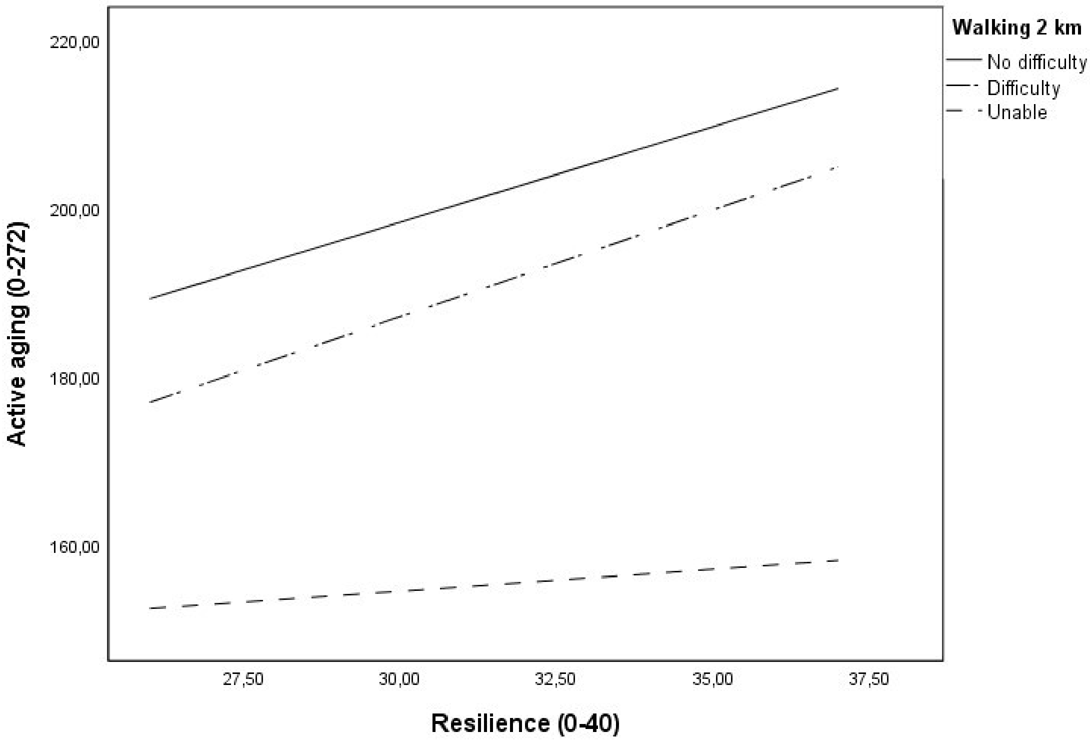

FIGURE 8 Illustration of the age-adjusted ordinary least squares path analysis with psychological resilience as a moderator of the relationship between difficulties walking 2 km (reporting walking difficulty or being unable to walk independently vs. reporting no difficulty) and active aging (UJACAS) among all study participants (n=961). The moderation effect was probed using regression centering with the 16th, 50th, and 84th percentiles of the distribution of the resilience scale describing relatively low, moderate, and relatively high values. The moderation effect was statistically significant at all these levels (p<.001 for all).

5.5 The effects of an individualized active aging counseling intervention on mobility, physical activity and resilience (Study IV)

The aim of the fourth sub-study was to investigate whether a one-year individualized counseling intervention that aims to support autonomous motivation and promote engagement in any self-selected activity affected pre-planned secondary outcomes on mobility and physical activity. In this dissertation, the potential changes in resilience were also investigated. It was hypothesized that improvements in mobility, physical activity and resilience would be greater in the intervention group than in the control group, which only received printed information on health in general.

TABLE 10 Means of mobility variables and resilience score in the intervention and control groups at pre-trial and post-trial, and p-values for group, time, and group by time effects tested with GEE analysis.

Outcome	Pre-trial Mean SD)	Post-trial Mean (SD)	Group p	Time p	Group x time p
Physical performance			.010	.060	.022
Intervention	10.6 ± 1.6	11.2 ± 1.3			
Control	11.0 ± 1.2	11.2 ± 1.1			
Life-space mobility			.482	.807	.409
Intervention	74.4 ± 9.2	76.3 ± 14.5			
Control	74.7 ± 9.3	74.9 ± 13.6			
Autonomy in mobility			.043	.204	.011
Intervention	4.2 ± 3.1	4.8 ± 3.3			
Control	4.7 ± 3.5	4.3 ± 2.5			
Self-reported PA[a]			.512	.012	.462
Intervention	58.9 ± 24.0	65.6 ± 24.3			
Control	60.3 ± 20.5	65.1 ± 22.6			
Average acceleration (*mg*)[b]			.401	.782	.603
Intervention	23.9 ± 5.9	24.0 ± 7.4			
Control	25.6 ± 8.4	25.3 ± 9.9			
No difficulty walking 2 km			.841	.994	.738
Intervention	81%	78%			
Control	84%	84%			
Resilience			.653	.512	.312
Intervention	31.6 ± 5.4	30.8 ± 5.2			
Control	31.7 ± 4.7	31.5 ± 4.1			

Note. N = 204 for other models except for [a] in which n = 203 and [b] in which n = 139.
PA = physical activity, mg = milligravity

As Table 10 shows, group, time, and group by time effects did not become statistically significant for difficulty walking 2 km, life-space mobility, monitored physical activity (average acceleration), or resilience. The effect of time was statistically significant for self-reported physical activity, indicating that physical activity increased in both the intervention and control groups (p = .012). Group by time effects were significant only for physical performance (p = .022) and perceived autonomy in outdoor mobility (p = .011) indicating that change over time was different between the intervention and control groups in these outcomes. Physical performance improved more in the intervention than control group, whereas sense of autonomy in outdoor mobility declined in the intervention group and improved in the control group (Figure 9). The effect size for the change in physical performance was d=.31 (95% confidence interval CI 0.02 - 0.59) and for perceived autonomy d=.36 (95% CI 0.07 - 0.64).

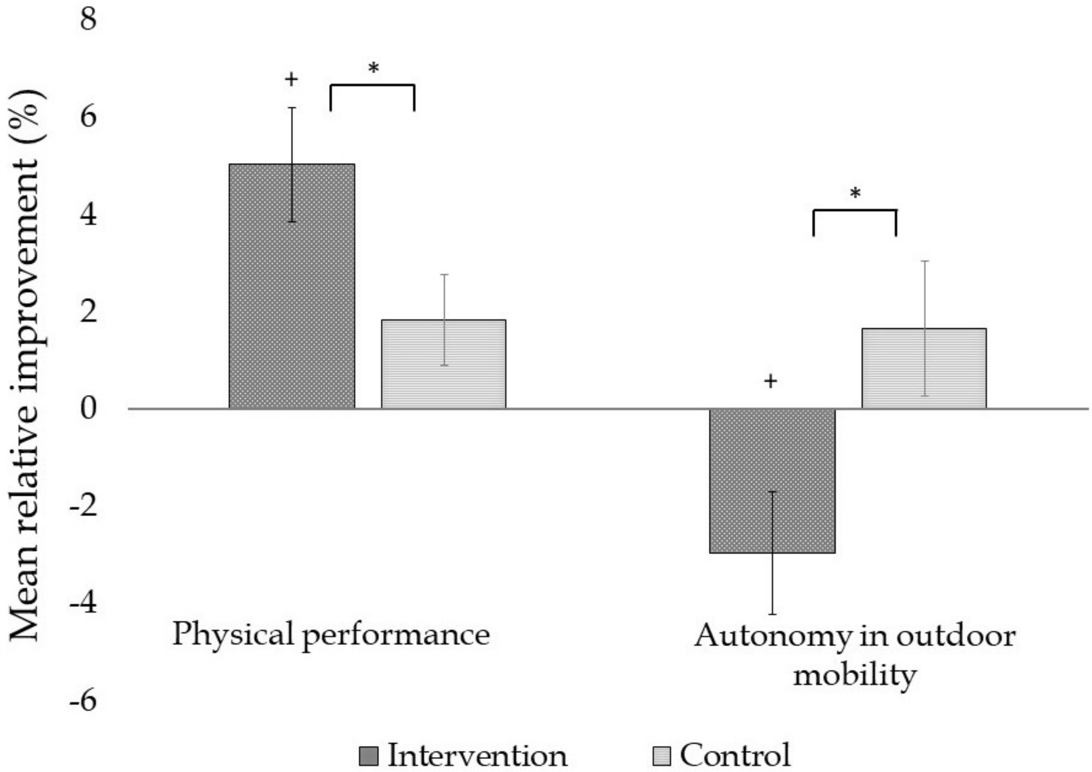

FIGURE 9 Mean relative improvements (%) with standard errors in physical performance and perceived autonomy in outdoor mobility by treatment-group allocation. * Significant between-groups difference, + significant within-group difference, p<.05

6 DISCUSSION

This study shows that psychological resources may, as expected, modify the associations between mobility decline and activity. While decreased cognitive function together with poor physical function seems to further increase the odds for walking difficulty compared to having deficits in only one or the other domains of functioning, high levels of resilience and coping may help in maintaining greater levels of outdoor mobility and overall activity despite early phase mobility decline. In line with previous suggestions (Morrow-Howell et al. 2014; Portegijs et al. 2014c) these findings imply that psychological resources may play an important role in explaining why some people retain their out-of-home mobility and activity at a higher level than others. Another main finding of the study is that individualized counseling aimed at supporting autonomous motivation and increasing any meaningful activity did not have systematic effects on mobility, physical activity or resilience outcomes. While associations of striving to engage in meaningful activity with greater life-space mobility and physical activity have been reported in previous observational studies (Saajanaho et al. 2014; Saajanaho et al. 2015), the present study is, to the author's best knowledge, the first to report on causality and find that slightly increased meaningful activity (Rantanen et al. 2020) did not translate into improved outdoor mobility.

6.1 Associations between mobility and activity

To study whether psychological resources modify the associations between mobility decline and activity, it was necessary to confirm the initial associations between mobility and activity. In line with the established theories describing the disablement process (Verbrugge & Jette 1994; World Health Organization 2001) and the results of previous empirical studies (e.g. Guralnik et al. 1994; Fried et al. 2001; Rantanen et al. 2001; Mänty et al. 2007), this study also found that mobility modifications and limitations, leading eventually to restrictions in activity, were more common among persons with functional decline than among those with intact physical function. However, this study extended previous findings by also addressing, for the first time to the author's best knowledge, the associations between perceived walking difficulty and active aging. The results showed, first, that poorer physical performance increased the odds for reporting walking modifications and walking difficulties over a 2km distance at baseline and the risk for incident walking difficulty over a two-year follow-up. These associations remained after multiple adjustments, including for number of chronic conditions, depressive symptoms, and cognitive function, thereby adding to the robustness of the findings. A plausible explanation for such strong associations between physical performance and walking difficulties is that adequate muscle strength and postural balance are biomechanical prerequisites for walking (Rantanen et al. 1999; Rantanen et al. 2001; Rantanen 2013). Second, those who reported difficulty or inability to walk 2km (independently) scored lower on the active aging scale than those with intact walking ability. It has been reported earlier that walking difficulties make it more taxing to leave the home to access local amenities and activities (Rantakokko et al. 2013; Rantanen 2013). Hence, experiencing walking difficulty typically reduces a person's life-space mobility (Rantakokko et al. 2017) and may, eventually, lead to the abandonment of valued activities in out-of-home environments (Saajanaho et al. 2016b). These are plausible explanations for the negative association found between walking difficulties and active aging.

Although this study supported the hypothesis that resource losses in mobility have a negative influence on activity, no clear confirmation was found for the association being reciprocal, as the individualized active aging intervention had non-systematic effects on mobility and physical activity. Depending on the specific aspect of mobility studied, the effects of the intervention were inconsistent, as physical performance improved and sense of autonomy in outdoor mobility declined in the intervention group, self-reported physical activity increased in both groups, and no treatment effects were observed for life-space mobility, perceived difficulties walking 2 km or monitored physical activity. Moreover, although statistically significant, the effect sizes for the changes in physical performance and perceived autonomy in outdoor mobility were small, and hence, bore little relevance for everyday life.

Although previous observational studies have demonstrated that striving to achieve activity-related goals is important, as it is associated with higher life-space mobility (Saajanaho et al. 2015) and predicts greater exercise activity (Saajanaho et al. 2014), the present results suggest that encouraging older people to set new activity-related goals and trying to change their everyday behaviors is not an easy task. The present intervention had only small effects on its primary outcome, active aging (Rantanen et al. 2020). Thus, it is understandable that the changes in secondary outcomes, reflecting mobility and physical activity, were also modest. In addition, many participants strove to maintain their current activities rather than set new activity goals. While this maintenance orientation in goal pursuit typically outweighs growth orientation in later life and correlates with greater well-being (Ebner et al. 2006), it may partially explain why so little variability was observed in the present mobility and activity outcomes. Furthermore, although the intervention was centered on promoting engagement in activities outside the home, participants were supported in striving to achieve any goals they found important. These goals sometimes included sedentary as well as non-sedentary at-home activities.

The inconsistencies in the effects of the intervention may partially be explained by the characteristics of the measurement instruments used. First, a statistically significant improvement was observed in physical performance measured with the SPPB. The SPPB is highly sensitive to change (Ostir et al. 2002) and can capture smaller improvements than, for example, the binary walking difficulty variable. Second, self-reported physical activity increased in both groups whereas no change was observed in objectively monitored PA. This may be due to the fact that self-reports are vulnerable to social desirability and approval bias (Adams et al. 2005), and hence overestimations of activity (Steene-Johannessen et al. 2016). The Hawthorne effect, which refers to the phenomenon where people start to behave differently when they know that they are being studied (Becker et al. 2003), may explain why increases were also seen in the control group. Finally, anecdotal data from the counseling sessions demonstrated that some participants in the intervention group started resistance training and home exercises, which may not be fully captured with the current activity measures or life-space mobility questionnaires. However, these activities will likely improve lower extremity performance (Rantanen 2013) and translate into better physical function scores.

Counter to the author's expectations, perceived autonomy in outdoor mobility declined in the intervention group and improved in the control group. It is possible that the intervention group participants became more aware of the activities available to them but, because the intervention did not include practical help in performing them, an imbalance may have occurred between the participants' desires and their resources. In addition, the counseling approach included behavioral change techniques such as problem solving and action planning, the aim being to help participants find social and practical support for performing their selected activities in everyday life. However, the present findings on declined autonomy in outdoor mobility suggest that the SDT and TPB theories and the behavioral change techniques utilized may have not been sufficient for these purposes.

6.2 Additive effects of cognition and physical performance

In addition to establishing an association between poorer physical performance and walking difficulty, this study shows that the odds for reporting walking difficulty are even higher among those experiencing a decline in both physical performance and cognitive function. This finding supports the hypothesis that resource loss in mobility combined with resource loss in cognition results in maladaptation. It is also in line with previous findings on the negative consequences of experiencing decline in both physical and cognitive function (Clouston et al. 2013; Demnitz et al. 2016). However, the novel contribution of this study is that it extends the previous findings to the early phase of mobility decline, and, to the author's best knowledge, is the first to report on the combined associations of cognitive function and physical performance with perceived walking modifications and difficulty.

Previous studies have reported that people having cognitive complaints combined with slowed gait, also named the motoric cognitive risk syndrome (MCR) (Verghese et al. 2012), are at increased risk for dementia (Verghese et al. 2012; Montero-Odasso et al. 2016), mortality (Ayers & Verghese 2016) falls (Callisaya et al. 2016), and higher odds for cardiovascular diseases and their risk factors (Beauchet et al. 2018) than those without MCR. Moreover, it has been found that cognitive decline combined with self-reported mobility limitations increases the risk for institutionalization (von Bonsdorff et al. 2006). In line with these findings, the present cross-sectional results showed increased odds for experiencing difficulty walking 2 km among persons with poorer physical and cognitive function. Cognitive decline and mobility decline seemed to have additive effects on walking difficulty, as the odds for walking difficulty were twice as high among those showing a decline in cognition alone, five times higher among those showing a decline in physical performance, and eight times higher among those with deficits in both than persons with intact cognition and physical performance. This indicates that considering both dimensions of function at the same time will likely help identify populations at greatest risk for mobility disability.

The present longitudinal findings did not fully resemble the cross-sectional findings. In the longitudinal analyses, risk for walking difficulty was not increased by either poor cognitive function alone or by poor lower extremity function combined with low cognitive capacity. This may be due to a decline in the ability to evaluate their own functioning among persons with cognitive deficits. It has previously been found that persons with more severe cognitive decline tend to under-report their difficulties in everyday life (Farias et al. 2005). No data were available in Study I to investigate whether those who initially had lower cognitive capacity exhibited further decline, which, if so, might explain the absence among them of self-reported walking difficulties at follow-up. Another possible explanation for the inconsistent findings is the high prevalence of walking difficulties at baseline among those with poorer physical performance and cognition. Of the 73 people in this category, 50 already had walking difficulties at baseline and were excluded from the prospective analyses. Consequently, the analyses may have been unpowered and the risk for incident walking difficulty an underestimation in this group.

Finally, when the logistic regression model was adjusted for physical performance, the association between cognitive function and walking difficulty was attenuated. Further analysis showed that the association between cognitive function and walking difficulty was mediated by physical performance. Physical performance thus partially explained the relationship between cognitive decline and walking difficulty. Previously, poorer physical performance has been shown to explain the association between executive function, which is a higher order cognitive function, and life-space mobility, which is a correlate of 2 km walking ability (Poranen-Clark et al. 2018a). Moreover, the present finding is partially in line with previous suggestions that both cognitive and physical function are affected by a joint biological aging process (Clouston et al. 2013) and that this process may initially be observed as deficits in physical function, and subsequently, as deficits in cognition (Best et al. 2016; Dumurgier et al. 2017).

Overall, the present findings suggest that lack of cognitive capacity may make it harder for older individuals to adapt to losses in mobility and, most notably, further increase the odds for walking difficulties among those with early-phase deficits in physical function. Based on the present findings, older persons with a decline in both cognition and physical performance represent a particularly vulnerable group and thus should be targeted in future interventions.

6.3 Positive roles of coping and resilience

As expected, the active use of coping strategies and possession of higher levels of resilience were associated with greater outdoor mobility and active aging. In particular, tenacity in goal pursuit coincided with greater life-space mobility, whereas high psychological flexibility was associated with better sense of autonomy in outdoor mobility. Most notably, resilience moderated the association between walking difficulties and active aging. Among those with and without difficulty walking 2 km, the higher their level of resilience, the greater their active aging score. This supports the idea of resource interaction proposed in the COR theory (Hobfoll 2002) by showing that losses in one domain, in this case mobility, may be compensated by adopting other resources, here coping strategies. However, the results also demonstrated that when encountering more advanced mobility limitations, i.e., the inability to walk 2 km, resilience may lose its alleviating effect. As these findings are from cross-sectional studies, further investigations are needed to understand the longitudinal associations of resilience with mobility and activity.

It was found that older persons who pursue their goals with determination and commitment but, when needed, are able to modify them to better correspond to changes in their resources, had a higher sense of autonomy in outdoor mobility and greater life-space mobility. In contrast, persons who showed low levels of both tenacity and flexibility in goal pursuit perceived the most constraints in out-of-home mobility. This is likely explained by higher depressive symptomology among persons with low tenacity and flexibility, as all the associations were attenuated or even became statistically non-significant when the models were adjusted for depressive symptoms. Although it has been debated whether demonstrating both high tenacity and flexibility is maladaptive and leads to situations where people are faced with the dilemma of choosing between holding on or letting go (Bailly et al. 2016), the present findings support the more prevalent view that a combination of high tenacity and flexibility is favorable for well-being (Kelly et al. 2013; Bailly et al. 2016). The present findings, however, extend previous ones to the context of outdoor mobility by showing that persons with high tenacity and flexibility may enjoy the benefits of persistent goal pursuit while simultaneously avoiding the pitfalls related to persevering with blocked goals.

As speculated by Kelly et al. (2013), it is likely that psychological flexibility and tenacity influence positive and negative well-being differently, "with increased tenacity contributing to increased positive well-being, and increased flexibility protecting against increases in negative well-being". In Study II, it was found that low tenacity, irrespective of moderate flexibility, coincided with restricted life-space mobility. Low flexibility, irrespective of high tenacity, in turn, was associated with poorer perceived autonomy. This implies that flexibility may function as an important resource for supporting sense of autonomy, while persistency may encourage older people to maintain out-of-home mobility and engagement in community life. Further, according to the dual process model conceptualized by Brandtstädter and Renner (1990), while tenacity and flexibility may represent diverse coping strategies, they typically interact in real-life situations. The present findings supported this by showing that in addition to identifying persons who were more tenacious than flexible, or vice versa, we found a group of people who scored high on both tenacity and flexibility. Overall, these findings suggest that both coping strategies should, as cognition and physical function, be researched as a combined entity. Moreover, the findings indicate that tenacity may be more important than flexibility for moving in out-of-home environments, although the importance of flexibility has often been emphasized in later life (Rothermund & Brandstädter 2003; Brandtstädter 2009; Bailly et al. 2012).

The literature on coping profiles is very limited, and this study is among the first to report on tenacity and flexibility as a combined coping entity rather than as distinct strategies. Bailly and colleagues (2016) identified the same three profiles as found in this study. However, to the author's best knowledge, the present study is the first to report on a fourth coping profile describing persons in the least favorable position, i.e. with low tenacity and low flexibility. The identification of this fourth coping profile supports a recent finding that persons exhibiting low flexibility are also likely to be low in tenacity (Martinent et al. 2017). Compared to those in the study by Bailly et al. (2016), the present study participants were older. Moreover, those in the low tenacity and low flexibility profile had the highest mean age (85.0 years), which may explain the absence of this profile in the study by Bailly et al. (2016). Nevertheless, the cluster solution suggested here was not fully stable, as one of the five analyses failed to identify the low tenacity and low flexibility profile. Hence, further studies are needed to better understand older people's tendencies to utilize different coping strategies.

In addition to establishing positive associations between tenacity, flexibility, and outdoor mobility, it was found in this study that resilience moderated the association between walking difficulty and active aging by enabling a more active life among persons with early-phase functional decline. This finding shows that resilience may be an essential resource for aging people, who typically start to face difficulty walking longer distances. Similarly, in a recent study, tenacity was found to moderate the association between physical performance and participation in leisure activities such that those with higher tenacity were more likely to participate in leisure activities even in the presence of physical decline (Tourunen et al. 2020). The mitigating role of resilience may be explained by a better ability to compensate for functional losses. People with higher resilience are often determined and persistent in their efforts to realize their aspirations (Dyer & McGuinness 1996; Lamond et al. 2008), and thus may more easily come up with new ways of doing so (Rothermund & Brandstädter 2003). It is also likely that people with higher resilience compensate for their mobility limitations by applying adaptive strategies, for example walking modifications. Walking modifications have recently been reported to aid in maintaining greater life-space mobility and perceived autonomy in outdoor mobility (Skantz et al. 2019). The active use of compensatory strategies among older people with physical limitations and high well-being has also been reported elsewhere (Carpentieri et al. 2017).

However, although resilience was similarly associated with active aging among 75-, 80- and 85-year-olds, even after adjusting the OLS regression models for walking difficulties, the moderation effect of resilience was robust only among the 75-year-olds. This implies that the ability to compensate for functional losses may decline as people age, as also previously suggested (Rothermund & Brandstädter 2003). In contrast to Rothermund & Brandtstädter (2003), who found that the use of compensatory strategies declined already after age 70, the present study showed that 75- and 80-year-old people may also be able to actively compensate for their functional losses. Instead, 85-year-olds may have fewer socio-economic resources to facilitate compensatory actions and therefore not perceive active engagement in various out-of-home activities in as realistic a light as the younger old (Saajanaho et al. 2016a). For example, in the present study it was found that the 85-year-olds had lower educational level and a greater proportion of them was living alone compared to the younger cohorts. Moreover, it has previously been reported that, when faced with losses and challenges, those among the oldest-old with high levels of resilience typically shift their focus to what they still can, rather than cannot, do (Hayman et al. 2017). Second, compensatory strategies require sufficient resources (Ebner et al. 2006; Saajanaho et al. 2016a), rendering the cost-benefit ratio of compensation often unfavorable for old-old persons (Baltes & Smith 2003; Rothermund & Brandstädter 2003). Consequently, instead of striving to undertake numerous activities by employing a variety of adaptive strategies, the oldest-old may perceive it more feasible to select and try to retain only the most meaningful of their activities when encountering deficits in mobility. Among the 85-year-olds, this may be considered as loss-based selection (Baltes 1997), resulting in equal well-being and meaningfulness of life, while manifesting as lower active aging scores.

In addition to adopting compensatory strategies that help maintain engagement in selected activities, people with high resilience may also be able to embrace totally new activities that are more feasible. It has previously been reported that participation in passive activities, such as reading, watching television and talking on the phone increases with advancing age, whereas more active activities such as volunteer work and travel become less popular (Cho et al. 2018). This reflects flexibility in adaptation to functional decline and deficits in other resources. The sensitivity analyses of Study III showed that people with walking difficulties and high levels of resilience maintained a greater level of activity than those with low levels of resilience by engaging in activities that can be performed closer to home and make less demands on mobility. For example, they reported higher activity in practicing memory, balancing finances, making one's home cozy, and maintaining friendships than those with lower levels of resilience. Hence, instead of giving up on an active life completely, people with high resilience may be more likely to strive to realize activities that better correspond to their diminished mobility.

Finally, it was shown that resilience may not be sufficient to fully compensate for more advanced limitations in mobility, here operationalized as the inability to walk 2km. One plausible explanation for this relates to comorbidity, as more advanced mobility limitations typically co-exist with other health and functional deficits, such as cognitive decline (Atkinson et al. 2005; Clouston et al. 2013; Demnitz et al. 2016) and depression (Thorpe et al. 2011; Milaneschi & Penninx 2014). These, in turn, may have further negative influences on goal pursuit and activity and hence predispose to maladaptation. In this study, those who reported being unable to walk 2 km independently had significantly lower MMSE scores than those without or with walking difficulties. In addition, they were also more likely to have trouble walking 500 m. Moreover, it is probable that positive psychological adaptation alone cannot compensate for the inability to walk independently, as it is such a drastic loss of function and, especially, of autonomy. Inabilities reflect diminished personal and social resources, and make people more dependent on help and support from others (Rantanen 2013). Lastly, the present resilience scores clustered towards the lower end of the scale among persons reporting inability to walk 2km. Statistically, this makes it hard to test the moderation effect of a high level of resilience and detect a significant association.

Altogether, these findings indicate that coping and positive adaptation may have alleviating roles as modifiers of the association between mobility decline and activity. Older people may be able to maintain a higher level of meaningful activity if they possess adequate determination, persistence and psychological flexibility, as these may help in adapting to changed circumstances and adopting compensatory strategies. In contrast to earlier research, which has emphasized the importance of flexibility and accommodation among older people (Rothermund & Brandstädter 2003; Brandtstädter 2009; Bailly et al. 2012), this study demonstrated that tenacity and determination are also central for maintaining greater outdoor mobility in old age.

6.4 Methodological considerations

This study utilized data from two larger study projects: LISPE and AGNES, both of which included additional sub-studies (MIIA and AGNES intervention, respectively). The LISPE data already existed and hence required careful familiarization with the study protocol prior to conducting the analyses. The AGNES data, in turn, were collected during the first years of this doctoral research and the author was also part of the AGNES research group. Hence, I participated in planning and implementing the study. For example, I carried out baseline home-interviews, took part in the intervention counseling sessions, and gathered and mailed the health information to the control group. Consequently, I was very familiar with the AGNES data. The LISPE and AGNES studies both utilized population-based samples, meaning that the study subjects were representative of all social strata and included both men and women. In addition, in the AGNES intervention study, probability sampling, which typically decreases selection bias, was used. However, since the study protocols were rather time-consuming and demanding, especially in the AGNES intervention, which required a visit to the research center, the recruited participants were rather well-functioning. Furthermore, it has been reported that studies on activity and mobility often attract older persons who are initially healthy and interested in these topics (Portegijs et al. 2019). Hence, the findings of this study may not be applicable to older persons with poorer health and function. In both projects, participant burden was minimized by using power calculations to define optimal sample sizes and by carefully designing the study protocols (what to include and in which order) in a multi-disciplinary research group. Finally, data were mainly collected face-to-face in the participants' homes, which decreases the amount of missing data. Overall, the data used for the present study were of good quality.

This study targeted older people aged 75 to 90 years. This age range represents the time of life when people typically start to experience a (notable) decline in health and function. As the timing and speed of functional decline vary greatly between individuals (Ferrucci et al. 2016), targeting a rather wide age range makes it possible to detect persons with intact function, persons in the very early phase of functional decline and persons with more advanced limitations and comorbidities. The AGNES participants did not represent the full age range from 75 to 85 years but just three (75, 80 and 85 yrs., Study III) or two (75 and 80 yrs., Study IV) specific ages. The AGNES participation rate declined with age (Portegijs et al. 2019), and hence the younger age cohorts were somewhat better represented also in the present study. Having data on people aged

75, 80 and 85 in Study III allowed us to compare levels of resilience at different points in old age, an approach that has rarely been taken hitherto.

A notable strength of this study is the use of three different types of study design. LISPE was a prospective cohort study with a two-year follow-up (Rantanen et al. 2012), which allowed the author to investigate the incidence of walking difficulty in Study I. The availability of longitudinal data is important, as the deterioration of walking ability is a process (Mänty et al. 2007; Rantakokko et al. 2013). In addition, with the cross-sectional evidence found for the combined associations of decline in cognition and decline in physical performance, it was possible to both hypothesize and demonstrate that these are precursors of walking difficulty. Studies II and III, in turn, utilized cross-sectional data and hence did not allow determination of the directions of the observed associations. However, given the novelty of the research questions and the paucity of literature on their topics, the use of cross-sectional study designs was justified in Studies II and III. Now, they lay a foundation for future hypotheses and further investigations. Finally, in Study IV we utilized an RCT design, which is the golden standard for studying causality (Cartwright 2010).

Although longitudinal and RCT study designs are often considered more valuable than cross-sectional studies, the present longitudinal and RCT data can be critiqued. First, in Study I, only baseline data on cognition and physical performance was available, as these had not been assessed at follow-up. Thus, the present analysis was unable to include examination of further deficits in cognition or physical performance or competing risks of new comorbidities. These topics await future studies. Nevertheless, study attrition was generally very low. This may support the validity of our findings. Another limitation is that in Study IV, only two assessment points existed: baseline and the one-year follow-up. Consequently, the author was unable to investigate potential changes in mobility and physical activity in between these time points. It is possible that mobility and physical activity improved immediately following the face-to-face counseling sessions but declined again when face-to-face contact was replaced by phone calls and the counseling sessions became less frequent. Further investigations are needed to better understand what happens between pre- and post-trial assessments. In future studies, it might also be beneficial to include an additional post-trial assessment to establish the long-term effects of an intervention. However, because the short-term effects of the present active aging intervention on mobility and physical activity were only modest and non-systematic, it is likely that its long-term effects would also have been marginal.

Another strength of this study is that it takes a comprehensive view on mobility and thereby addresses the call to incorporate a wide spectrum of mobility measures that can provide information not only about individuals' maximal performance but also about their real-life mobility (Rosso et al. 2013). In this research, aspects that relate to mobility performance, mobility behavior and autonomy in outdoor mobility were considered. As these aspects are influenced by different background factors (Webber et al. 2010), they complement each other and, combined, provide an explicit picture of a person's overall mobility.

In addition, mobility was assessed by using both subjective questionnaires and objective tests and activity monitors, making it possible to control for the challenges and biases related to subjective mobility measures, such as overestimations of activity and performance (Steene-Johannessen et al. 2016), and those related to objective measures, such as lack of relevance for real-life mobility (Giannouli et al. 2016).

Assessing active aging with a new validated measure incorporating a wide range of essential life activities (Rantanen et al. 2019a) may also be considered as a strength of the present study. The UJACAS scale is flexible in the sense that it allows the study participant to define what the activity item involves. The activity items do not have to conform to strict criteria, and hence, the item "maintaining friendships", for example, may mean going for walks together and meeting for coffee for some, while for others (with more limited mobility) it may mean a phone call. Thus, this conceptualization of active aging also applies to those with limitations and disabilities and may have more relevance to public health than the established Rowe and Kahn model on successful aging, which is rather exclusive and applies only to the healthiest older people (Hicks & Conner 2014). Another novel feature of the UJACAS scale is that it considers older people's own preferences. This allows the scale to capture the phenomenon of active aging in all its various forms, as older people may demonstrate equal activity levels while striving to achieve different goals and activities. As relatively little continues to be known about the factors underlying active aging, this study, showing that walking difficulties are associated with lower active aging scores and that resilience may moderate this negative association, lays a foundation for future hypotheses.

The concept of resilience merits further consideration. In the literature, the prevalent view of resilience centers on processes of positive adaptation (Luthar et al. 2000; Rutter 2006; Southwick et al. 2014), with resilience often used as an outcome variable (Luthar et al. 2000; Masten 2001). Here, since no relevant longitudinal data were available, measuring positive adaptation to mobility decline per se was not possible. Instead, this study utilized the CD-RISC10 scale, which reflects a person's personal competence, tenacity, tolerance of negative affect, positive acceptance of change, and personal control (Connor & Davidson 2003), and thus identifies persons who are likely to recover or thrive should an adverse event occur. The CD-RISC10 scale thus measures the availability of various resilience factors rather than the adaptation process itself (Chmitorz et al. 2018). The scale has shown good validity in the present sample (Tourunen et al. 2019) and has been widely used in aging research (Cosco et al. 2016; MacLeod et al. 2016). In addition, as the scale assesses resilience through its attributes, such as the use of coping strategies, it was easy to compare and contrast the findings of Studies II and III. Nevertheless, in future studies, it could be fruitful to study resilience in a longitudinal setting, as this would enable (attributes of) resilience to be examined both before and after exposure to a stressor, such as mobility decline.

Finally, it should be noted that, as part of larger research projects, all the present analyses can be considered secondary. The original protocols of the LISPE, MIIA and AGNES studies were not primarily designed for the purposes of this study, and therefore the sample sizes and assessment methods were perhaps less than optimal. For example, in Study I, it might have been fruitful to have studied cognitive function in greater depth by including tests for specific cognitive domains. It is also possible that recruiting participants with lower cognitive and physical function would have enhanced the statistical power of the analyses in Study I and produced more variability in the outcomes of Study IV. Nevertheless, several established and validated scales and tests were utilized, and the sample sizes were rather large in general. This may explain why we detected statistically significant associations also between the present variables. Finally, the use of larger datasets with information about, e.g., socioeconomic status, health and living circumstances, enabled adjustments for several plausible confounders.

Despite its limitations, this study addresses a novel field and lays a foundation for future research. Previously, resilience and coping strategies have mainly been studied in relation to psychological outcomes, while only a marginal amount of research have addressed their relationship with mobility and activity outcomes. To the author's best knowledge, this is the first study to investigate resilience and coping as modifiers of the negative association between mobility and active aging and to examine the joint associations of cognitive and physical decline with perceived walking difficulty. The findings of this study contribute to the literature on the factors underlying greater out-of-home mobility and meaningful activity and help to frame novel hypotheses for future studies.

6.5 Future directions

Many gerontological studies have focused on investigating how deficits in function and health in older populations eventually lead to disability and death. Thus, a body of evidence has accumulated on the negative consequences of aging. However, aging is not solely about deterioration and survival. Many older people possess a lot of potential and demonstrate high levels of wellbeing and happiness (Ong & Bergeman 2004; Jopp & Rott 2006). This realization has recently generated discussion on the "paradox of aging", a phenomenon in which age-related losses are translated into gains in wellbeing (Charles & Hong 2016). The interesting, yet unanswered, question has been: how can older people live life to its fullest despite functional deficits? The present study has added significantly to this novel discourse on aging. It was found that older people with the determination and ability to adapt to changing circumstances may enjoy a more active life even with early-phase deficits in mobility. The finding that psychological resources may also have a central role in living an active and meaningful life in old age indicates that more emphasis should be placed on the potential that older people already have – establishing age-related deficits and disabilities is only part of the story. However, it was also shown that not possessing certain resources, such as adequate cognitive capacity, may predispose to mobility disability, and eventually, activity restriction. Thus, in addition to designing interventions aimed at preventing functional decline, future studies should also invest in interventions aimed at fostering psychological resources.

Overall, this study demonstrates that psychological resources should be considered more often in mobility research. While the examination of cognitive function in addition to that of physical performance may enhance the accuracy of risk prediction and help identify those at greatest risk for future disability, integrating resilience and coping measures into studies on mobility may help in understanding inter-individual variation in mobility and activity outcomes that is not explained by physiology. On the issue of coping, a further novel finding in this study was that tenacity, rather than flexibility, encourages older people to leave their homes. This shows, as also previously proposed (Tourunen et al. 2020), that the role of tenacity in later life should not be overlooked. In addition, these findings suggest that taking resilience and cognition into account when developing interventions aiming at preventing mobility disability may also prove fruitful. Finally, as earlier suggested (Wild et al. 2013; Smith & Hollinger-Smith 2014), the present findings indicate that resilience – in addition to high physical and cognitive function and engagement in meaningful activity – might usefully be considered a new key component of aging well.

However, it is noteworthy that the observational results of this study were not fully supported in the causal analyses, as the intervention showed that active aging, physical activity and different aspects of mobility were either not affected at all or affected only marginally when older people were provided with counseling targeted at motivational constructs and the provision of social support. First, these slightly contradictory findings between the observational and experimental studies emphasize that, to get a realistic and comprehensive understanding of associations between mobility, psychological resources and activity, different study designs are needed. While the findings of this study provide evidence of the existence of significant associations, future studies are required to establish the directions and magnitudes of these relations. Second, the null findings of the intervention imply that changing everyday behaviors is challenging, and prompt the question: Can active aging even be promoted in the first place, and if so, how, when and for who? Disentangling this issue merits further attention. On the other hand, the findings also emphasize the fact that mobility, activity and psychological resources are complex constructs. As the study questions and variables were not exactly the same between the different sub-studies, we cannot rule out the possibility that the results are not conflicting but rather describing different aspects of an existing causal phenomenon.

On the promotion of mobility and physical activity at the population level, future interventions might be more effective than the one applied here if they were specifically designed to promote engagement in activities that demand more mobility and are also more physical in nature. This is suggested, as previous studies have reported positive results of individualized physical activity counseling interventions on physical function (Mänty et al. 2009) and physical activity (Rasinaho et al. 2012). Furthermore, it is possible that the intervention would have been more effective if the study participants had been less active and/or in a need of change initially. According to anecdotal data from the AGNES intervention study, the best feedback was received from persons who had, for example, widowed recently. For them, the intervention was timely and aided in finding new ways to be active after a dramatic change in everyday life. Thus, it is possible that future interventions would benefit from targeting specific populations with will to and need for change.

At a more specific level, future studies on the joint associations of physical performance and cognitive function with walking difficulty could benefit from studying executive function in addition to overall cognition. Executive function is controlled by prefrontal brain areas, which are in charge of motor control and tend to deteriorate first with advancing age (Seidler et al. 2010). Hence, walking ability is largely dependent on executive function (Best et al. 2016). In addition, measures of executive function typically detect early cognitive decline better than the MMSE, the measure of overall cognition used here (Juby et al. 2002). Moreover, future studies should establish whether self-reported walking difficulty is a suitable method for assessing mobility decline among persons with cognitive impairments or whether the level of physical functioning in this specific group of older people should always be externally evaluated.

7 MAIN FINDINGS AND CONCLUSIONS

The main findings of the present study can be summarized as follows:

1. Older people with decline in physical performance and cognitive function were more likely to manifest difficulty walking 2 km than those with neither or only one or the other, thereby rendering them especially vulnerable to further disability. Studying physical performance together with cognitive function may improve the accuracy of risk prediction for mobility disability.

2. Utilizing both tenacious goal pursuit and flexible goal adjustment as coping strategies was associated with greater outdoor mobility. While flexibility was important for supporting perceived autonomy in outdoor mobility, tenacity seemed to encourage older people to move in a larger life-space.

3. High levels of psychological resilience helped older people with early-phase mobility limitations to maintain meaningful activity. However, while resilience seemed to mitigate the negative effects of walking difficulty on active aging, it also seemed to be insufficient to fully compensate for more severe impairment in mobility, here conceptualized as the inability to walk 2 km.

4. The individualized counseling intervention designed to support autonomous motivation and increase any self-selected activity had inconsistent effects on mobility and physical activity. While the intervention improved physical performance slightly, modest decreases were observed for sense of autonomy in outdoor mobility. No changes were found for the other outcomes studied, including life-space mobility and monitored physical activity.

YHTEENVETO (SUMMARY IN FINNISH)

Psyykkiset voimavarat liikkumiskyvyn ja aktiivisuuden välisen yhteyden muovaajina ikääntyessä

Aktiivisuus viittaa kaikkeen ihmisen toimintaan ja on täten paljon enemmän kuin vain liikkumista. Sitä ohjaavat ihmisten omat tavoitteet ja motivaatio. Aktiivisena vanheneminen viittaa kaikkeen ihmisen toimintaan hänen tavoitteidensa, kykyjensä ja mahdollisuuksiensa puitteissa. Sen ajatellaan edistävän hyvinvointia ja mahdollisesti myös ylläpitävän tai parantavan liikkumiskykyä ja lisäävän fyysistä aktiivisuutta. Ikääntyessä liikkumiskyky tyypillisesti heikkenee, mikä vaikeuttaa kotoa poistumista sekä monien palveluiden ja aktiviteettien pariin pääsyä. Liikkumiskyvyn heikkeneminen voi siis rajoittaa mahdollisuuksia aktiivisena vanhenemiseen. Viimeaikaisissa tutkimuksissa on havaittu, että jotkut ikäihmiset pysyvät aktiivisina liikkumiskyvyn heikkenemisestä huolimatta. Vielä ei kuitenkaan ole selvää miksi. Psyykkiset voimavarat kuvaavat yksilön henkisiä reservejä, jotka edistävät mielen hyvinvointia ja auttavat selviytymään vastoinkäymisistä. On mahdollista, että runsaat psyykkiset voimavarat auttavat mukautumaan liikkumiskyvyn heikkenemiseen ja täten ylläpitämään aktiivisuutta. Jos taas psyykkisiä voimavaroja ei ole riittävästi tai niitä ei osata hyödyntää, on mahdollista, että aktiivisuus vähenee entisestään.

Tämän tutkimuksen tarkoituksena oli selvittää muokkaavatko psyykkiset voimavarat kuten kognitiivinen toimintakyky, resilienssi eli sitkeys, sekä sinnikkyys ja joustavuus omien tavoitteiden suhteen oletettuja negatiivisia yhteyksiä liikkumiskyvyn heikkenemisen ja aktiivisuuden välillä. Tutkimuksen toinen tarkoitus oli selvittää, onko yksilöllistetyllä aktiivisena vanhenemista edistävällä neuvontainterventiolla vaikutuksia myös liikkumiskykyyn, fyysiseen aktiivisuuteen ja/tai resilienssiin.

Tutkimuksessa hyödynnettiin aineistoa kahdesta eri tutkimusprojektista. Iäkkäiden ihmisten liikkumiskyky ja elinpiiri (LISPE, n=848) oli kaksivuotinen prospektiivinen seurantatutkimus ja Elinpiiri ja aktiivisena vanheneminen (MIIA, n=206) sen poikkileikkauksellinen jatkotutkimus. Aktiivinen vanhuus – AGNES -tutkimusprojekti taas koostui erillisistä kohortti- ja interventiotutkimuksista (n=1021 ja n=204, tässä järjestyksessä). AGNES-interventio kesti vuoden ja sisälsi neuvontaa, jolla pyrittiin tukemaan yksilön autonomista motivaatiota sekä lisäämään arjen aktiivisuutta hänen omien tavoitteidensa mukaisesti. Tutkittavat olivat kotona asuvia 75-93-vuotiaita henkilöitä. Liikkumiskykyä ja aktiivisuutta mitattiin sekä itseraportointiin perustuen että objektiivisesti mitaten. Liikkumiskykyä kuvaavia muuttujia olivat fyysinen toimintakyky, koetut kävelyvaikeudet 2 km matkalla, elinpiiriliikkuvuus sekä ulkona liikkumisen autonomia. Resilienssiä, sinnikkyyttä ja joustavuutta mitattiin itsearviointiin perustuvilla kyselyillä, ja kognitiota standardoidulla testillä.

Tulokset osoittivat, että fyysinen toimintakyky oli yhteydessä kävelyvaikeuksien kokemiseen sekä poikittais- että pitkittäisasetelmassa. Kun heikentyneeseen fyysiseen toimintakykyyn yhdistettiin lisäksi heikentynyt kognitiivinen toimintakyky, todennäköisyys kokea kävelyvaikeuksia nousi entisestään ja oli lähes kahdeksankertainen verrattuna tilanteeseen, jossa fyysinen ja kognitiivinen toimintakyky olivat hyvät. Kävelyvaikeudet puolestaan olivat yhteydessä heikompiin aktiivisena vanhenemisen pisteisiin. Lisäksi havaittiin, että omien tavoitteidensa suhteen sinnikkäillä ja joustavilla henkilöillä oli suurin liikkuvuus elinpiirissä ja korkein koettu ulkona liikkumisen autonomia. Pienin elinpiiri ja heikoin ulkona liikkumisen autonomia taas oli henkilöillä, jotka eivät olleet sinnikkäitä eivätkä joustavia. Sinnikkyys oli erityisesti yhteydessä elinpiiriin. Tulokset osoittivat myös, että resilienssi moderoi aktiivisena vanhenemisen ja kävelyvaikeuksien välistä yhteyttä. Korkeampi resilienssi oli yhteydessä korkeampiin aktiivisena vanhenemisen pisteisiin henkilöillä, jotka eivät kokeneet kävelyvaikeuksia ja henkilöillä, jotka kokivat kävelyvaikeuksia. Sen sijaan henkilöillä, jotka eivät enää pystyneet kävelemään 2 km matkaa itsenäisesti, korkeampi resilienssi ei lisännyt aktiivisena vanhenemista. Lopuksi havaittiin, että aktiivisena vanhenemista edistävällä neuvontainterventiolla ei ollut johdonmukaisia vaikutuksia liikkumiskykyyn, fyysiseen aktiivisuuteen tai resilienssiin. Intervention seurauksena fyysinen toimintakyky parani hiukan, mutta ulkona liikkumisen autonomia heikkeni. Kirjallista terveystietoa saaneessa kontrolliryhmässä ulkona liikkumisen autonomia taas parani. Muissa vastemuuttujissa ei nähty merkitsevää muutosta interventio- ja kontrolliryhmien välillä.

Tämän tutkimuksen tulokset tukevat oletusta siitä, että psyykkiset voimavarat fyysisten voimavarojen lisäksi voivat selittää yksilöiden välisiä eroja aktiivisuudessa. Fyysisellä ja kognitiivisella heikkenemisellä saattaa olla toisiaan vahvistava negatiivinen vaikutus liikkumisvaikeuksien syntyyn. Tästä johtuen kognition huomioiminen fyysisen toimintakyvyn lisäksi voi tulevaisuudessa auttaa tunnistamaan ikäihmiset, jotka ovat erityisessä riskissä aktiivisuuden rajoittumiselle. Mielen sitkeys, sinnikkyys ja joustavuus sen sijaan voivat auttaa kompensoimaan liikkumiskyvyn heikkenemistä ja täten ylläpitämään aktiivisuutta – ainakin henkilöillä, joilla liikkumiskyvyn heikkeneminen on vielä vähäistä. Aktiivisena vanhenemista edistävän interventiotutkimuksen tulokset sen sijaan olivat ristiriitaisia ja marginaalisia. Tämän tutkimuksen perusteella jäi siis epäselväksi, voiko aktiivisuutta ja aktiivisena vanhenemista ylipäänsä edistää, ja jos voi, niin millä tavoin ja missä kohderyhmässä. Tulevien tutkimusten tulisi tarkemmin selvittää liikkumiskyvyn, psyykkisten voimavarojen ja aktiivisuuden välisten yhteyksien suuntaa ja ajallista järjestystä.

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ORIGINAL PAPERS

I

THE COMBINED EFFECT OF LOWER EXTREMITY FUNCTION AND COGNITIVE PERFORMANCE ON PERCEIVED WALKING ABILITY AMONG OLDER PEOPLE: A 2-YEAR FOLLOW-UP STUDY

by

Siltanen S., Portegijs E., Saajanaho M., Poranen-Clark T., Viljanen A., Rantakokko M. & Rantanen T. 2018.

Journals of Gerontology: Series A, Medical Sciences 73(11): 1568-1573

DOI: https://doi.org/10.1093/gerona/gly103

Journals of Gerontology: Medical Sciences
cite as: *J Gerontol A Biol Sci Med Sci*, 2018, Vol. 73, No. 11, 1568–1573
doi:10.1093/gerona/gly103
Advance Access publication 8 May 2018

Research Article

The Combined Effect of Lower Extremity Function and Cognitive Performance on Perceived Walking Ability Among Older People: A 2-Year Follow-up Study

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Received: December 19, 2017; Editorial Decision Date: April 21, 2018

Decision Editor: Anne Newman, MD, MPH

Abstract

Background: We studied the combined effects of cognitive performance and lower extremity function on self-reported walking modifications and walking difficulty and on self-reported walking difficulty incidence over a 2-year follow-up.
Methods: A total of 848 community-dwelling older people aged 75–90 years participated at baseline, 816 at the 1-year follow-up, and 761 at the 2-year follow-up. Baseline lower extremity function was measured with the Short Physical Performance Battery (<10 vs. ≥10) and cognitive performance with the Mini–Mental State Examination (<24 vs. ≥24). Difficulty in walking 2 km was self-reported and categorized into no difficulties, no difficulties but walking modifications, and prevalent difficulties. Data were analyzed with multinomial and Cox regressions and a mediation analysis.
Results: At baseline, 33% reported no walking difficulties, 25% walking modifications, and 42% walking difficulty. Poorer lower extremity function and lower cognition increased the odds for walking difficulty. For those with both, the odds were almost eightfold higher for walking difficulty and threefold higher for walking modifications compared with having neither. Poorer lower extremity function mediated the association between low cognition and poorer perceived walking ability. Of those with no walking difficulty at baseline, 31% developed walking difficulty during the follow-up, the risk being almost twofold higher among those with poorer lower extremity function at baseline (hazard ratio = 1.82, 95% confidence interval = 1.28–2.59).
Conclusion: Older people with poorer lower extremity function and cognitive performance are likely to have walking difficulties, rendering them especially vulnerable to further disability. Cognitive performance should be considered in interventions aimed at preventing mobility disability.

Keywords: Cognition, Physical function, Physical performance, Mobility limitation

Walking ability is important for accessing community amenities (1) and for maintaining independence in old age (2). Self-report measures of walking provide information about one's mobility in the everyday environment and usually express the degree of difficulty perceived when walking a specific distance (1). Perceived walking ability relates closely to actual walking behavior (1,3). Self-report measures may also identify people who modify their walking, that is, change their way of walking (4). Modifications in walking, such as slowing down or pausing for rest during performance, may indicate declining functional capacity even in the absence of frank walking difficulty (4). People with walking modifications represent an intermediate level of functional capacity when compared with those reporting walking difficulty and with those reporting no walking difficulty and no modifications (4,5). However, modifications also denote adaptive compensatory practices, as these may help older people to maintain their life-space mobility and participation in out-of-home activities regardless of their physical decline (6).

Pathology or aging may cause impairments in physical and cognitive capacity (7). Moreover, it has been pointed out that decline in physical capacity often co-occurs with decline in cognition (8).

Three recent systematic reviews and meta-analyses reported on the associations of indicators of mobility with measures of cognition (9–11). Older people with poorer physical performance do worse in cognitive tests (9), and vice versa (10), and are at risk for developing dementia (11). This may stem from a common biologic aging process, which manifests as deficits in both physical and cognitive performance (9). Furthermore, it has been suggested that deficits may manifest first in physical performance as, at least in part, they are easier to observe than cognitive changes (12,13).

The combined deterioration of physical and cognitive performance may underlie perceived walking modifications and walking difficulties in old age. Two international workshop reports have suggested that research on mobility should incorporate cognitive measures and that cognition and mobility should be regarded as a combined research entity (14,15). Nevertheless, to our knowledge, the cognitive and physical domains have not hitherto been studied together as predictors of perceived walking difficulties. The purpose of this study, therefore, was to investigate the combined associations of cognitive performance and lower extremity function with self-reported walking modifications and walking difficulty cross-sectionally and with incidence of perceived walking difficulty over a 2-year follow-up. In addition, we studied whether lower extremity function mediates the association between cognition and perceived walking ability.

Methods

Study Design

This study forms part of the Life-Space Mobility in Old Age (LISPE), which was a 2-year (2012–2014) prospective cohort study targeting community-dwelling older people conducted at the University of Jyväskylä, Finland. Participants were recruited from a random sample of 2,550 people aged 75–90 years drawn from the national population register and living in the municipalities of Jyväskylä and Muurame in Central Finland. Of this number, 848 persons were eligible (living independently and able to communicate) and willing to participate in the at-home personal interview (16). Of these, 816 participated in the 1-year follow-up and 761 in the 2-year follow-up implemented by phone. Reasons for dropout over the 2-year period were death (n = 41), institutionalization (n = 15), impaired ability to communicate (n = 12), moving outside the study area (n = 6), declined health (n = 5), unwillingness to continue (n = 6), and not being reached (n = 2) (17).

The Ethical Committee of the University of Jyväskylä approved the LISPE study. The study protocol followed the guidelines of the Declaration of Helsinki. Participants were informed about the study, and each participant signed an informed consent before the assessments.

Variables

Perceived walking difficulty and walking modifications

Participants were asked if they perceived difficulties in walking 2 km (2,4) at baseline and at the 1- and 2-year follow-ups. The response options were as follows: "able without difficulty," "able with some difficulty," "able with a great deal of difficulty," "unable without the help of another person," and "unable to manage even with help." Those who reported being able to manage without any difficulty were asked whether they have modified their way of walking (4). The question was "Have you noticed any of the following changes in walking 2 km?" The response options were yes/no, and the items were decreased walking frequency, given up walking the distance, use of an assistive device, slower walking pace, and pausing for rest during the performance. Participants were categorized as follows: (a) no walking difficulties (reporting neither difficulty nor modifications), (b) walking modifications (reporting no walking difficulty but at least one modification), and (c) walking difficulties (reporting some or a great deal of difficulties or being unable to perform).

Lower extremity function

Lower extremity function was assessed at baseline with the Short Physical Performance Battery (SPPB) (18). The battery includes tests for standing balance (feet together, semi-tandem, full tandem), walking (normal gait speed for 2.44 m), and chair rise (five times). Each task was scored from 0 to 4, yielding a sum score of between 0 and 12 points (4), with higher scores indicating better performance. The sum score was calculated and scaled if at least two of the three tests were completed (19). In total, nine participants (1.0%) did not complete the tests due to refusal (n = 4), being in a wheelchair (n = 4), or a proscription from a doctor (n = 1). The sum scores were not normally distributed and thus were categorized. Participants with an SPPB score of 10 or higher (n = 529) were considered as having good physical performance and formed the reference group. Because only few participants had very low scores (<4 points, n = 28), no further categorization was possible, and hence, those with a score less than 10 were assigned to the category of poorer lower extremity function (n = 310) (20).

Cognitive performance

Cognitive performance was assessed at baseline with the Mini–Mental State Examination (MMSE), which is a brief screening test for cognitive impairment (21). It consists of 11 items measuring orientation, registration, attention, calculation, recall, and language. The maximum sum score is 30, higher scores indicating better performance. The sum score was scaled if the respondent was not able to perform all the test tasks, for example, due to visual impairment. Because the MMSE scores were not normally distributed in this study, we used the established cut point of 24 (22) to identify the participants with cognitive decline (MMSE < 24, n = 150). The remainder formed the reference category (MMSE ≥ 24, n = 698).

Covariates

Age and sex were drawn from the national population register, and year of education was self-reported. Morbidity was evaluated as the number of physician-diagnosed self-reported chronic conditions. A list of 22 diseases was presented, followed by an open-ended question asking about other conditions (19). Depressive symptoms were assessed with the 20-item Centre for Epidemiologic Studies Depression Scale (CES-D) (23). Vision was assessed subjectively with the question: "How well can you see from a distance?" The response options were dichotomized into (a) good (those who answered "well" and "reasonably well") and (b) declined (those who answered "poorly") (24).

Statistical Analyses

Means, *SD*, and percentages were used to describe the participants' baseline characteristics, and crude differences were tested with the chi-square test and one-way analysis of variance. The cross-sectional odds for walking modifications or walking difficulties versus no difficulty were calculated with multinomial regression analyses. The preliminary regression analyses revealed an interaction between the

MMSE and SPPB scores and walking modifications and difficulties ($p < .001$). Therefore, we first added the SPPB and MMSE into the models separately and thereafter together to assess the combined influences of poorer lower extremity function and lower cognitive performance. All models were first adjusted for age and sex and then additionally for years of education, number of chronic conditions, depressive symptoms, and vision. The model including only cognition was adjusted for lower extremity performance, and vice versa. In addition, a latent factor mediator analysis was conducted to assess whether SPPB mediated the association between MMSE and walking ability at baseline. The mediation analysis was adjusted for age and sex.

The incidence of walking modifications was too low for meaningful analysis. Thus, we used Cox regression to analyze the relative risk for incident walking difficulties among those who did not report walking difficulties at baseline (n = 492). People were censored at the time they reported walking difficulty or at the end of the follow-up, whichever happened first. Those who had missing data on walking ability in one or the other of the assessments were categorized and censored according to the answer that was available. In addition, the Cox regression analysis was stratified according to baseline modifications. Finally, Little's Missing Completely at Random (MCAR) test was used to analyze study attrition.

All analyses were performed with SPSS Statistics 24 for Windows except for the mediation analysis, where MPlus version 5.21 was used.

Results

Mean baseline age was 80.6 (SD = 4.3), and 62% of the participants were women. At baseline, 33% (n = 280) reported no walking difficulties, 25% (n = 212) reported walking modifications, and 42% (n = 356) reported walking difficulties. Those without walking difficulties had the best cognitive performance and lower extremity function, whereas those with walking difficulties had the poorest. Those reporting walking modifications had intermediate scores (Table 1). In addition, those with walking difficulties were older, less educated, more often women, and had more chronic conditions, depressive symptoms, and more often poor vision ($p \le .005$ for all) than those reporting no walking difficulties. These variables were chosen as covariates. The baseline characteristics according to lower extremity function and cognitive performance categories are presented in Supplementary Material.

Table 2 shows that poor cognitive performance was not associated with walking modifications but increased the odds for walking difficulties at baseline. Poorer lower extremity function increased the odds for both walking modifications and walking difficulties. The highest odds for walking difficulties were observed among those with concurrent poorer lower extremity function and poor cognition. A parallel, but less pronounced association was seen for walking modifications. In addition, those with good lower extremity function but poor cognition were likely to have walking difficulties, but only when the model was adjusted for all the covariates. The mediation analysis showed that the association of higher cognitive capacity with better-perceived walking ability was mediated through better lower extremity function. The direct association between MMSE and perceived walking ability was not significant (see Figure 1).

Of the 492 participants who did not report walking difficulties at baseline, 153 (31%) developed walking difficulty during the 2-year follow-up. Table 3 shows that poorer lower extremity function both alone and together with good cognition increased the risk for incident walking difficulty. When the analysis was stratified according to baseline walking modifications, those without walking modifications but with poorer lower extremity function and poor cognition were at risk of incident walking difficulty (hazard ratio = 2.75, 95% confidence interval = 1.01–4.17). Among those reporting walking modifications, the results remained nearly unchanged (data not shown). Study attrition was analyzed with Little's MCAR test, which showed that missing data were not missing completely at random ($\chi^2 = 9.756$, $df = 1$, $p = .002$). Thus, it was assumed that the mobility of those who reported no walking difficulties at baseline but dropped out during the follow-up due to death or institutionalization (n = 22) would have declined. Therefore, we categorized them as having developed walking difficulty to determine whether that would alter the results. The results supported our main findings (data not shown).

Discussion

The findings of this study suggest that older people with both poorer lower extremity function and low cognitive performance are more likely to have walking difficulties than those with neither or only the other, making them especially vulnerable to further disability. Poor lower extremity function as a risk factor for mobility modifications and disability has been reported earlier (4,7,18). Our results expand those findings by showing that the odds for reporting walking

Table 1. Baseline Characteristics of the Participants According to Walking Ability Category (N = 848)

Characteristics	No Walking Difficulties	Walking Modifications	Walking Difficulties	
	n = 280	n = 212	n = 356	
	Mean (SD)	Mean (SD)	Mean (SD)	p Value
Age	78.4 (3.7)	79.8 (4.3)	81.7 (4.1)	<.001[a]
Years of education	10.3 (4.5)	9.9 (3.7)	8.8 (4.0)	<.001[a]
Number of chronic conditions	3.2 (2.0)	4.2 (2.3)	5.4 (2.4)	<.001[a]
CES-D score	7.3 (5.7)	9.5 (6.0)	11.6 (7.5)	<.001[a]
MMSE score	26.6 (2.5)	26.1 (2.8)	25.8 (3.0)	.003[a]
SPPB score	10.8 (1.4)	10.1 (1.9)	8.4 (3.0)	<.001[a]
Sex (female, %)	53.9	58.5	70.5	<.001[b]
Vision (poor, %)	1.4	2.8	6.2	.005[b]

Note: CES-D = Centre for Epidemiologic Studies Depression Scale; MMSE = Mini–Mental state Examination; SPPB = Short Physical Performance Battery.
[a]Tested with one-way analysis of variance. [b]Tested with chi-square test.

Table 2. Cross-sectional Analyses of Lower Extremity Function and Cognitive Performance Separately and Combined With Self-reported Walking Modifications and Walking Difficulties Among Community-Dwelling Older People Aged 75–90 Years at Baseline (n = 827)

	Walking Modifications			Walking Difficulties		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
MMSE (<24 vs. ≥24)	1.62 (0.97–2.73)	1.73 (1.00–2.99)	1.57 (0.90–2.75)[a]	**1.97** (1.22–3.17)	**2.11** (1.25–3.57)	**1.81** (1.05–3.14)[a]
SPPB (<10 vs. ≥10)	**2.39** (1.55–3.71)	**2.07** (1.32–3.26)	**2.02** (1.28–3.18)[b]	**7.07** (4.71–10.62)	**5.24** (3.39–8.10)	**5.06** (3.26–7.84)[b]
SPPB ≥ 10 and MMSE < 24[c]	1.50 (0.79–2.82)	1.71 (0.88–3.33)	—	1.78 (0.95–3.35)	**2.04** (1.03–4.05)	—
SPPB < 10 and MMSE ≥ 24[c]	**2.39** (1.47–3.87)	**2.13** (1.29–3.51)	—	**7.18** (4.58–11.25)	**5.38** (3.32–8.73)	—
SPPB < 10 and MMSE < 24[c]	**3.08** (1.26–7.53)	**2.65** (1.05–6.69)	—	**9.70** (4.30–21.86)	**7.67** (3.27–18.04)	—

Notes: CI = confidence interval; OR = odds ratio; SPPB = Short Physical Performance Battery; MMSE = Mini–Mental State Examination. Reference category: no walking difficulties. Multinomial regression model 1: adjusted for age and sex. Model 2: adjusted for age, sex, years of education, number of chronic conditions, depressive symptoms, and vision. Model 3: adjusted for age, sex, years of education, number of chronic conditions, depressive symptoms, vision, and [a]SPPB, and [b]MMSE. [c]Versus SPPB ≥ 10 and MMSE ≥ 24. Statistically significant values are bolded.

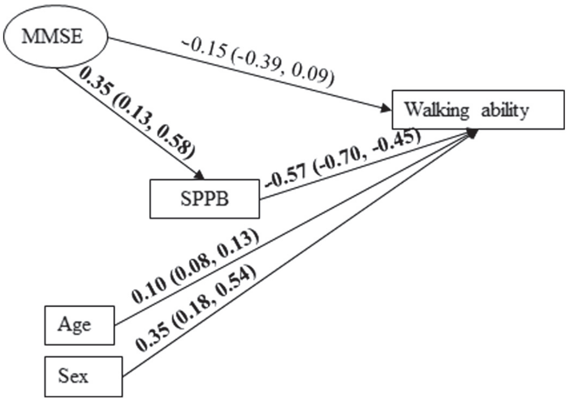

Figure 1. Unstandardized path coefficients with 95% confidence intervals of a cross-sectional, age- and sex-adjusted, latent factor mediator model for Mini–Mental State Examination (MMSE), Short Physical Performance Battery (SPPB), and perceived walking ability (Walking ability) among community-dwelling older participants (N = 848).

modifications or difficulties were highest among those with poorer lower extremity function and poor cognitive performance. The results are in line with previous findings on the association between mobility limitations and cognitive decline (9,10) but extend them by showing that the association is evident already in the early phase of mobility decline.

Recently, reports have shown that cognitive decline, together with slowed gait, in older people without dementia or mobility disability (25) increases the risk for dementia (25,26), mortality (27), and falls (28) when compared with people without this combination. In addition, the combination of objectively measured cognitive decline and mobility limitations has been found to increase the risk for institutionalization (29). Our cross-sectional results are in line with these studies but extend them for walking difficulties and support the view that studying mobility and cognition together improves the accuracy of risk prediction (9,14,15,26,30).

Our longitudinal results, however, were only partially parallel to those obtained in cross-sectional analyses, and most of the differences centered on cognitive capacity. Neither poor cognitive functioning nor poorer lower extremity function in the presence of low cognitive capacity was associated with increased risk for new walking difficulties. Previous studies have found that persons with more severe cognitive decline may under-report difficulties in everyday functioning (31). Our results indirectly supported this by showing an increased risk for walking difficulty solely among those with poorer lower extremity function and high MMSE score at baseline. Unfortunately, data were not available to examine whether those who initially had lower cognitive capacity exhibited further decline, which might underlie the absence of self-reported walking difficulties among them. Another explanation is the high prevalence of walking difficulties at baseline among those with poorer lower extremity function and low cognitive capacity. Of the 73 people in this category, 50 already had walking difficulties at baseline and were excluded from the prospective analyses. Consequently, we cannot rule out the possibility that the risk of incident walking difficulty is an underestimation in this group.

We found that the association between cognition and walking difficulties was attenuated when the model was adjusted for lower extremity function. Furthermore, the mediation analysis showed that the association of lower cognition with poorer walking ability was mediated by poorer lower extremity function. Thus, our findings suggest that poorer lower extremity function partially explains the association between cognitive decline and walking difficulties. A recent study indicated that lower extremity function also partially explains the association between executive function, a higher order cognitive function, and life-space mobility, a correlate of self-reported 2-km walking ability (32,33). The strong associations of lower extremity function with walking difficulties and walking modifications may be explained by age-related losses in muscle strength and postural balance, which are biomechanical prerequisites for walking (1,34,35).

We chose to study older people aged 75–90 years at baseline because that is usually the time of life when people start to experience decline in mobility and cognition. In addition to investigating the cross-sectional associations of cognition and lower extremity function with perceived walking modifications and difficulties, we conducted longitudinal analyses because the deterioration of walking ability is a process (2,4,36). The combined effects have been studied previously by comparing people with the combination of poor physical and poor cognitive performance with people without this combination (25,27). We were also interested in those with deficits in only one or other of the predictors. Thus, we categorized the participants based on clinical thresholds for lower extremity function and cognition and used the different combinations of these in our analyses. This enabled us to consider different profiles of

Table 3. Baseline Lower Extremity Function and Cognitive Performance as Separate and Combined Predictors of Walking Difficulty Incidence Over a 2-Year Follow-up Among Community-Dwelling Older People With No Walking Difficulties Regardless of Walking Modifications at Baseline (*n* = 492)

	Developing Walking Difficulty in 2 y		
	Model 1	Model 2	Model 3
	HR (95% CI)	HR (95% CI)	HR (95% CI)
MMSE (<24 vs. ≥24)	1.28 (0.84–1.95)	1.28 (0.83–1.98)	1.06 (0.68–1.67)[a]
SPPB (<10 vs. ≥10)	**1.85** (1.32–2.60)	**1.84** (1.30–2.60)	**1.82** (1.28–2.59)[b]
SPPB ≥ 10 and MMSE < 24[c]	1.47 (0.86–2.52)	1.59 (0.92–2.76)	—
SPPB < 10 and MMSE ≥ 24[c]	**2.10** (1.45–3.06)	**2.20** (1.50–3.22)	—
SPPB < 10 and MMSE < 24[c]	1.50 (0.77–2.92)	1.38 (0.70–2.71)	—

Note: CI = confidence interval; HR = hazard ratio; SPPB = Short Physical Performance Battery; MMSE = Mini–Mental State Examination. Reference category: no walking difficulties. Cox regression model 1: adjusted for age and sex. Model 2: adjusted for age, sex, years of education, number of chronic conditions, depressive symptoms, and vision. Model 3: adjusted for age, sex, years of education, number of chronic conditions, depressive symptoms, vision, and [a]SPPB, and [b]MMSE. [c]Versus SPPB ≥ 10 and MMSE ≥ 24.

functioning; however, it also prevented subgroup analyses because the groups were small and statistical power low. Finally, we chose MMSE and SPPB as indicators of cognitive and physical performance, as they are well-established measures of overall cognitive and physical performance. However, in the future, it might be beneficial to study executive function in addition to overall cognition because executive function is a more sensitive measure for detecting early cognitive decline than MMSE (37). In addition, executive function is closely related to walking (12) because it is controlled by prefrontal brain areas, which are important for motor control especially in old age (38).

Strengths and Limitations

The strengths of this study concern the study design and the measures used. First, we had a rather large population-based sample with little missing data. To our knowledge, this was the first study to examine the combined associations of lower extremity function and cognitive performance with perceived walking ability. Moreover, we used both well-established subjective and objective measures, the validity and reliability of which have been tested (4,18,20,21). Earlier research has tended to study walking objectively, whereas, given the stated need for assessment of real-world mobility (39), subjective measures may provide more comprehensive information about older people's mobility in their everyday environment (1). Furthermore, self-reports are an economical way to assess mobility in large samples (4). Using self-reported walking difficulties as an outcome also allowed us to study mobility modifications. Modifications precede walking difficulties but are signs of declining function and health (4). They have not yet been studied thoroughly and may not have been detected in traditional walking assessments.

This study has its limitations. First, we might not have covered the whole phenomenon of mobility modification. We used a structured question, which may not have included all possible changes in walking, to measure walking modifications. However, the measure has been validated (4). Furthermore, SPPB and MMSE were dichotomized in the analyses. Dichotomization reduces variability in data, rules out detection of dose–response relationships, and may lead to underestimation of associations. However, using established cutoff criteria makes the results more understandable and, in the present study, made it possible to examine the combined influences of lower extremity function and cognitive performance on walking ability. The MMSE cut point of 24 is commonly used to identify risk for dementia (22), but some people with impaired cognition may have scored above that cut point. It has been discovered that highly educated persons, especially, would need a higher cut point to represent their normal level of cognition (40). Another limitation is that we only used baseline characteristics as predictors of incident walking difficulties. Therefore, the analysis does not take into account competing risks of new comorbidities or subsequent cognitive decline or lower extremity impairments. However, the level of attrition was low, which may support the validity of the findings.

Conclusion

The findings of this study indicate that older people who concurrently manifest poorer lower extremity function and cognitive performance have the highest odds for walking difficulty. Thus, they are especially vulnerable to further disability. However, future studies should establish whether current methods to assess mobility among older people with cognitive impairment are adequate. Moreover, our results suggest that in addition to lower extremity function, cognitive performance should be taken into account when developing interventions aiming at preventing mobility disability. Furthermore, studying cognition and mobility as a combined research entity may improve the accuracy of risk prediction for mobility disability.

Supplementary Material

Supplementary data is available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

Funding

This study was supported by the European Research Council (grant number 693045 to T.R.); the Academy of Finland (grant number 255403 to T.R. and 285747 to M.R.); and the Ministry of Education and Culture (to T.R. and M.R.). The financial sponsors were not involved in the design, implementation, analyses, or reporting of the results.

Conflict of Interest

T.R. serves on the *Journal of Gerontology: Medical Sciences* editorial board. Otherwise, the authors declare no conflicts of interest.

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II

ASSOCIATION OF TENACIOUS GOAL PURSUIT AND FLEXIBLE GOAL ADJUSTMENT WITH OUT-OF-HOME MOBILITY AMONG COMMUNITY-DWELLING OLDER PEOPLE

by

Siltanen S., Rantanen T., Portegijs E., Tourunen A., Poranen-Clark T., Eronen J. & Saajanaho M. 2019.

Aging Clinical and Experimental Research 31(9): 1249-1256.

DOI: https://doi.org/10.1007/s40520-018-1074-y

Aging Clinical and Experimental Research (2019) 31:1249–1256
https://doi.org/10.1007/s40520-018-1074-y

ORIGINAL ARTICLE

Association of tenacious goal pursuit and flexible goal adjustment with out-of-home mobility among community-dwelling older people

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Received: 7 September 2018 / Accepted: 8 November 2018 / Published online: 17 November 2018

Abstract

Background As people age, functional losses may limit the potential to get outside the home and participate in desired activities and community life. Coping with age-related losses has been reported to be important for psychological well-being. Hitherto is not known whether active use of coping strategies also helps maintain out-of-home mobility.

Aims We investigated how two coping strategies, tenacious goal pursuit (TGP; persistency in reaching one's goals) and flexible goal adjustment (FGA; adjusting one's goals to changed circumstances), are associated with life-space mobility and perceived autonomy in participation outdoors among community-dwelling older people.

Methods Participants ($n = 186$) were aged 79–93 years. TGP and FGA were self-reported using separate scales. Perceived autonomy in participation was assessed with the Impact on Participation and Autonomy Outdoors-subscale, and life-space mobility with the Life-Space Assessment. Two-step cluster analysis was used to create data-driven coping profiles of TGP and FGA.

Results General linear model analyses showed that the profile including highly tenacious and flexible older people had the highest life-space mobility and perceived autonomy outdoors, whereas the profile including people with low TGP and low FGA showed the lowest scores. Depressive symptoms attenuated the associations.

Conclusions Active use of both TGP and FGA is favorable for out-of-home mobility and enables more active participation in society in later life.

Keywords Aging · Coping · Mobility · Participation · Autonomy

Introduction

Out-of-home mobility is a key element in living an active life in old age. Among community-dwelling older people, leaving the home is associated with greater physical activity [1] and better health and function [2, 3]. Furthermore, going outside the home enables older people to participate in valued activities and community life [4, 5]. Out-of-home mobility can be assessed with life-space mobility, which describes the size of the spatial area a person moves through in daily life, including the frequency of travel and assistance needed for that travel [6]. Thus, life-space mobility describes actual mobility behavior. Out-of-home mobility can also be assessed from a more personal point of view; perceived autonomy in participation outdoors describes an individual's self-rated possibilities to participate in activities outside the home and takes into account the meaning the individual attaches to these activities [7]. Life-space mobility and perceived autonomy in participation outdoors have been shown to be closely related, but not overlapping, concepts among older people [8].

The ecological theory of aging posits that an individual's behavior depends on personal competence (e.g. physical and cognitive performance) and environmental press (e.g. obstacles in the living environment) [9]. As physical and cognitive performance typically decline with age, people become more vulnerable to environmental press. This, in

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s40520-018-1074-y) contains supplementary material, which is available to authorized users.

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turn, may result in imbalanced person-environment fit [9]. In other words, moving around in one's surroundings becomes more and more difficult, leading to a decline in life-space mobility [10, 11] and perceived autonomy in participation outdoors [12]. However, some people with physical limitations remain highly active, indicating that they may possess other personal resources that enable them to engage in a wide range of activities [13].

Personal goals, i.e. self-selected objectives people want to achieve or avoid [14], guide human behavior [15, 16]. Active striving towards personal goals helps maintain meaningful activities throughout the life span [16] and retain life-space mobility at a higher level with aging [17]. However, age-related functional losses may limit the potential for action, resulting in a need to review and modify one's goals [16, 18, 19]. Successful goal modification may in turn increase possibilities for participation in new activities. The dual-process model of assimilative and accommodative coping posits two ways of coping with adversity: tenacious goal pursuit (TGP) and flexible goal adjustment (FGA) [18, 20]. TGP, or assimilative coping, refers to persistence and increased effort in adjusting the current situation in line with personal goals, whereas FGA, or accommodative coping, refers to adjusting one's preferences in response to changes in one's life circumstances by disengaging from blocked goals or by downgrading their importance [18, 20]. These coping strategies are important for maintaining well-being in old age. Older people who are high in both tenacity and flexibility are less likely to suffer from depression [20–22], a correlate of restricted life-space mobility [23]. Further, older people who actively use both strategies seem to report higher life-satisfaction, and better self-rated health [21, 22].

Potentially, high tenacity and high flexibility may also underlie more active out-of-home mobility among older people. These coping strategies, however, have mainly been studied in relation to psychological outcomes and thus, to our knowledge, their potential role as resources for maintaining out-of-home mobility in later life remains unknown. Hence, we investigated how TGP and FGA are associated with life-space mobility and perceived autonomy in participation outdoors among community-dwelling older people.

Methods

Study design

This study used cross-sectional data gathered for the Mobility and Active Aging study (MIIA) conducted at the University of Jyväskylä, Finland. The present participants were randomly selected from among the 848 participants of the Life-Space Mobility in Old Age (LISPE), which was a larger population-based study with a probability sample from the national population register [24]. The present sample was planned to comprise only part of the original LISPE sample, since the power calculations showed that a sample of 200 persons would be sufficient for statistically significant, moderate correlations. Thus, 298 persons were invited to participate. Of these, 77 declined to take part and 15 were not reached. Thus, the present data were gathered from 206 community-dwelling older adults who were aged 79–93 years, able to communicate and living independently in the Central Finland municipalities of Jyväskylä and Muurame.

Of the 848 LISPE participants, the present 206, who also participated in the MIIA study, were somewhat younger (80.0, standard deviation SD 4.1, vs. 80.8, SD 4.3, $p=0.02$), and had slightly better cognition (Mini Mental State Examination, 26.6, SD 2.3, vs. 26.0, SD 2.9, $p=0.01$) and physical performance (Short Physical Performance Battery, 10.2, SD 1.8, vs. 9.5, SD 2.7, $p<0.001$) than the others ($n=642$). The LISPE + MIIA and LISPE-only participants did not differ by sex, number of chronic conditions, or years of education.

The present data were collected by computer-assisted face-to-face home interviews in spring 2016. In total, 186 participants answered the questions on TGP, FGA, perceived autonomy and life-space mobility. The study protocol was approved by The Ethical Committee of the University of Jyväskylä. Participants signed informed consents before the assessments.

Measures

Tenacious goal pursuit and flexible goal adjustment

Coping was assessed with short versions of the Tenacious Goal Pursuit (TGP) and Flexible Goal Adjustment (FGA) scales, originally developed by Brandtstädter and Renner [20]. The short versions of the scales each contain five items, such as 'Even when things seem hopeless, I keep on fighting to reach my goal' (TGP) and 'If I do not get something I want, I take it with patience' (FGA) [22]. The response options are consistent with a five-point Likert scale: 'strongly agree' (0), somewhat agree (1), doesn't agree or disagree (2), somewhat disagree (3), and 'strongly disagree' (4). There is one inversely phrased item in both scales. Henselmans et al. [25] reported weak face validity for the inversely phrased items. In the present study, the Cronbach's alphas were higher when the inversely phrased items were omitted (TGP: $\alpha=0.77$ without vs. $\alpha=0.72$ with the inversely phrased item, FGA: $\alpha=0.67$ vs. $\alpha=0.60$). Moreover, the correlations between the directly and inversely phrased scores were rather low (TGP: $r=0.02$–0.18, FGA: $r=0.09$–0.21). Thus, we omitted the inversely phrased items. The remaining four items in both scales were reverse-scored with higher scores indicating higher tenacity or flexibility, and a sum score (range 0–16) was calculated for each scale when responses were given to at least three of the four items. Single missing items were imputed with the mean of the existing values of the respective participant ($n=3$ in TGP, $n=3$ in FGA). We excluded 20 participants from the analyses, since they had not responded to any of the questions concerning coping. These participants had lower cognition than the participants included in the analysis (MMSE mean 23.9 vs. 26.1, respectively) and had missing data also in the depression questionnaire (CES-D). We could not use any other time points to estimate responses for these participants.

Perceived autonomy in participation outdoors

The 'autonomy outdoors' subscale of The Impact on Participation and Autonomy (IPA) questionnaire was used to assess perceived autonomy in out-of-home activities. The IPA is a validated measure, which can be used as a whole or in part (subscales) to assess participation and autonomy [26, 27]. The 'Autonomy outdoors' subscale comprises five items on perceived possibilities to (1) visit relatives and friends, (2) make trips and travel, (3) spend leisure time, (4) meet other people, and (5) live life as one wants. The response options range from 'very good' (0) to 'very poor' (4). A sum score (range 0–20) was calculated with higher scores indicating poorer autonomy.

Life-space mobility

Life-space mobility refers to the spatial area an individual purposely moves through in daily life. It factors in all movement irrespective of the mode of transportation and reflects person's access to community amenities. It was measured with the Finnish version [24] of the University of Alabama at Birmingham Study of Aging Life-Space Assessment (LSA) [6]. The assessment includes six life-space areas starting from the informant's bedroom and expanding to include the home, yard, neighborhood, town, and beyond town. Participants are asked how often they have moved in each area during the 4 weeks preceding the assessment and whether in doing so, they have needed help from any devices or another person. In the analyses, we used a life-space mobility composite score, which reflects the distance, frequency, and level of independence of mobility, with higher scores (range 0–120) indicating higher life-space mobility [6]. The reliability and validity of the LSA measurement have been established [6, 10].

Covariates

In addition to age and sex, which were drawn from the national population register, objectively measured physical and cognitive performance and entrance-related environmental barriers were regarded as theory based confounders. Cognitive performance was assessed with the Mini Mental State Examination (MMSE) [28] and lower extremity function with the Short Physical Performance Battery (SPPB) [29]. Environmental barriers at entrances and in close exterior surroundings were objectively recorded using the Housing Enabler screening tool [30, 31]. Depressive symptoms were assessed with the Centre for Epidemiologic Studies Depression Scale (CES-D) [32].

Descriptives

Morbidity was evaluated as the number of self-reported physician-diagnosed chronic conditions from a list of 22 diseases including, e.g. coronary artery disease, diabetes, cancer, and Alzheimer's disease. An additional open question was asked about conditions other than those on the list [24]. Years of education was also self-reported.

Statistical analyses

First, the correlations between TGP, FGA, life-space mobility, and perceived autonomy in participation outdoors were tested with Pearson's correlation. Thereafter, to identify the different coping profiles in our sample, we performed a cluster analysis of TGP and FGA using two-step clustering. Two-step clustering identifies groupings by first running pre-clustering and then running hierarchical methods. Log-likelihood was used as a distance measure and the number of clusters was not determined beforehand. Since cluster solutions can depend on the order of cases, the order was randomized before the analysis. To test the stability of the given solution, cluster analysis was executed four additional times using different randomizations of cases. Differences in background characteristics between the resulting coping profiles were analyzed with chi square test and one-way analysis of variance.

Finally, general linear modeling was used to study the associations of the coping profiles with life-space mobility and perceived autonomy in participation outdoors. The base model was adjusted for age and sex. SPPB, MMSE, environmental barriers, and depressive symptoms were added to the base model one at a time to see which one of them possibly affects the associations. All analyses were performed with SPSS Statistics 24 for Windows.

Results

Participants' mean age was 84.0 (standard deviation, SD 4.1) and 56.3% ($n=116$) of them were women. The mean TGP score across all participants was 11.7 (SD 3.2) and the mean FGA score was 12.3 (SD 2.7). TGP correlated with both life-space mobility ($r=0.26$) and perceived autonomy in participation outdoors ($r = -0.26$), whereas FGA correlated only with perceived autonomy ($r = -0.27$).

The two-step cluster analysis yielded four coping profiles: (1) high TGP and high FGA (31.7%), (2) moderate TGP and low FGA (28.5%), (3) low TGP and moderate FGA (26.3%), and (4) low TGP and low FGA (13.4%, Fig. 1). The solution remained in four of the five cluster analyses in each of which the participants were differently randomized. The one deviant analysis yielded a three-cluster solution, failing to identify the profile of low TGP and low FGA. Comparison of the participants in the different coping profiles revealed that those with low TGP and low FGA had the poorest scores in cognitive performance, CES-D, life-space mobility, and perceived autonomy, while those high in TGP and FGA reported the least depressive symptoms and restrictions in perceived autonomy, and the highest life-space mobility (Table 1).

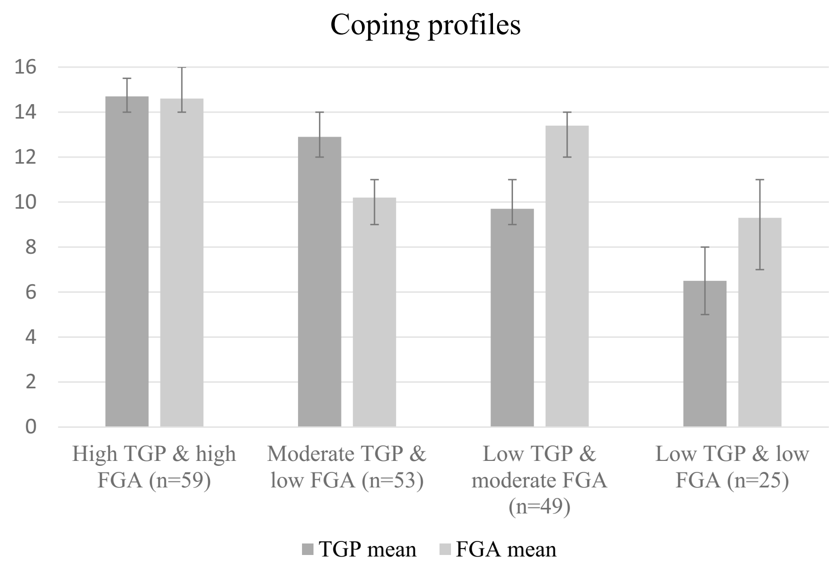

Fig. 1 Data-driven coping profiles created with two-step cluster analysis and described with means of tenacious goal pursuit (TGP) and flexible goal adjustment (FGA) in each cluster (ranges 0–16). Error bars represent the interquartile range of the TGP and FGA scores in each cluster

Table 1 Background characteristics of the participants by coping profile

	Coping profiles				
	High TGP and high FGA $n=59$	Moderate TGP and low FGA $n=53$	Low TGP and moderate FGA $n=49$	Low TGP and low FGA $n=25$	*p* value
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Age	83.6 (4.0)	83.4 (4.0)	84.1 (4.0)	85.0 (4.3)	0.40[a]
Number of chronic conditions	4.2 (2.6)	4.5 (2.8)	4.8 (2.6)	4.3 (2.0)	0.65[a]
Years of education	9.5 (3.8)	10.3 (5.2)	9.8 (3.5)	10.9 (5.4)	0.57[a]
MMSE	26.6 (2.3)	26.6 (2.2)	26.6 (2.8)	24.9 (3.9)	0.04[a]
SPPB	9.4 (2.0)	9.2 (2.3)	8.9 (3.0)	8.5 (1.9)	0.37[a]
Number of environmental barriers	11.7 (4.0)	11.0 (3.9)	10.8 (4.0)	11.3 (3.2)	0.63[a]
CES-D	6.0 (5.3)	10.7 (7.3)	10.7 (7.0)	12.6 (7.8)	< 0.001[a]
LSA	67.6 (18.2)	61.1 (22.1)	57.2 (21.3)	53.7 (21.4)	0.02[a]
IPA outdoors	4.4 (3.5)	7.2 (3.9)	7.5 (4.2)	8.3 (3.8)	< 0.001[a]
Sex (female) %	52.5	52.8	57.1	64.0	0.77[b]

MMSE Mini Mental State Examination, *SPPB* Short Physical Performance Battery, *CES-D* Centre for Epidemiologic Studies Depression Scale, *LSA* Life-Space Mobility Composite Score, *IPA* Impact on Participation and Autonomy Outdoors Score

[a]Analysis of variance

[b]Chi-square test

The general linear models showed that those with low TGP and low FGA had the lowest life-space mobility, except when the model was adjusted for physical or cognitive performance (Table 2). The lowest life-space mobility was then observed among those with low TGP and moderate FGA, while the association with low TGP and low FGA became non-significant. In terms of perceived autonomy in participation outdoors, those with low TGP and low FGA showed the poorest scores even after adjusting for cognitive or physical performance or entrance-related barriers (Table 3). When depressive symptoms were added to the base model, the associations were attenuated in terms both of life-space mobility and perceived autonomy in participation outdoors (Tables 2, 3). For life-space mobility, all the associations became non-significant.

Discussion

The findings of this study indicate that older people who persistently pursue their goals, but at the same time are also able to change their goals to better correspond to their current resources, perceive better possibilities to participate in activities outside the home and move across a wider life-space. In contrast, those showing the lowest tenacity and flexibility in pursuing their goals reported the most constraints on out-of-home mobility. This is likely explained by their high prevalence of depressive symptoms. Hence, our findings are not only in line with previous suggestions that being highly tenacious and flexible is the most favorable combination for well-being [21, 22], but extend them to out-of-home mobility. Furthermore, our findings indicate that tenacity is more important than flexibility for life-space mobility. Thus, although the importance of flexibility is often emphasized in later life [18, 33], it seems that tenacity is more crucial when it comes to physically moving around outside of the home.

Table 2 Marginal means (MM) and standard errors (SE) of life-space mobility scores and regression coefficients (*B*) with 95% confidence intervals (CI) by coping profile

General linear models	Coping profile							
	High TGP and high FGA		Moderate TGP and low FGA		Low TGP and moderate FGA		Low TGP and low FGA	
	MM (SE)		*B*	95% CI	*B*	95% CI	*B*	95% CI
Unadjusted	67.6 (2.7)	Ref.	−6.57	−14.27, 1.13	**−10.38**	−18.25, −2.51	**−13.91**	−23.62, −4.19
Age and sex	66.9 (2.4)	Ref.	**−6.95**	−13.81, −0.10	**−9.04**	−16.05, −2.04	**−10.35**	−19.05, −1.66
Age, sex, SPPB	65.7 (1.9)	Ref.	−4.52	−10.13, 1.10	**−6.47**	−12.16, −0.77	−5.77	−12.91, 1.37
Age, sex, entrance barriers	67.6 (2.5)	Ref.	**−7.98**	−14.99, −0.96	**−10.20**	−17.42, −2.99	**−10.68**	−19.58, −1.77
Age, sex, MMSE	66.5 (2.3)	Ref.	**−6.86**	−13.45, −0.28	**−9.19**	−15.93, −2.45	−7.43	−15.92, 1.06
Age, sex, CES-D	64.9 (2.3)	Ref.	−3.84	−10.85, 3.18	−6.41	−13.51, 0.70	−6.69	−15.58, 2.20

Statistically significant values are bolded

TGP tenacious goal pursuit, *FGA* flexible goal adjustment, *SPPB* Short Physical Performance Battery, *MMSE* Mini Mental State Examination, *CES-D* Centre for Epidemiologic Studies Depression Scale

Table 3 Marginal means (MM) and standard errors (SE) of perceived autonomy in participation outdoors scores and regression coefficients (*B*) with 95% confidence intervals (CI) by coping profile

General linear models	Coping profile							
	High TGP and high FGA		Moderate TGP and low FGA		Low TGP and moderate FGA		Low TGP and low FGA	
	MM (SE)		*B*	95% CI	*B*	95% CI	*B*	95% CI
Unadjusted	4.4 (0.5)	Ref.	**2.82**	1.39, 4.26	**3.11**	1.64, 4.59	**3.87**	2.06, 5.68
Age and sex	4.5 (0.5)	Ref.	**2.87**	1.49, 4.29	**2.96**	1.54, 4.39	**3.50**	1.74, 5.26
Age, sex, SPPB	4.7 (0.4)	Ref.	**2.58**	1.34, 3.83	**2.59**	1.32, 3.87	**2.86**	1.27, 4.44
Age, sex, entrance barriers	4.5 (0.5)	Ref.	**2.90**	1.48, 4.32	**2.96**	1.49, 4.43	**3.38**	1.57, 5.18
Age, sex, MMSE	4.5 (0.5)	Ref.	**2.87**	1.48, 4.23	**2.98**	1.55, 4.04	**3.31**	1.52, 5.09
Age, sex, CES-D	5.4 (0.4)	Ref.	**1.50**	0.23, 2.76	**1.74**	0.45, 3.02	**1.77**	0.16, 3.37

Statistically significant values are bolded

TGP tenacious goal pursuit, *FGA* flexible goal adjustment, *SPPB* Short Physical Performance Battery, *MMSE* Mini Mental State Examination, *CES-D* Centre for Epidemiologic Studies Depression Scale

Both coping strategies aim at reducing discrepancies. According to the dual process model of assimilative and accommodative coping, tenacious persons stay committed to a goal, even when facing hardship, by actively trying to modify the situation to better correspond to their personal preferences and by coming up with new ways of doing things [18]. However, some goals remain unachievable and persistent efforts to strive for them become ineffective. Therefore, flexible goal adjustment is needed to rescale goals within a feasible range or to channel efforts towards new, more feasible goals [18]. Based on the findings of this study, it seems that being persistent but at the same time able to adapt to constraints when necessary, enables people to move across a wider life-space as well as perceive possibilities for doing so. Thus, our findings support the view that people who actively utilize both coping strategies can enjoy the benefits of persistent goal pursuit but also are able to avoid the detrimental effects of persevering in blocked goals [21, 22]. In addition, these results are in line with a previous finding that coming up with new ways of doing things can alleviate environmental press [34].

In contrast, those with the lowest tenacity and flexibility had the lowest life-space mobility and poorest perceived autonomy in participation outdoors. In this profile, restricted life-space mobility was explained by poorer cognitive and physical function. This finding is in accordance with the ecological theory of aging, which posits that moving in one's surroundings becomes harder as personal competence declines [9]. It is also plausible that functional decline makes it harder to come up with new solutions to overcome obstacles. Furthermore, the association of poorer coping skills with lower life-space mobility was explained by the higher prevalence of depressive symptoms among those who were the least tenacious and flexible. Depression typically causes people to stay inside the home and withdraw from activities [23, 35]. On the other hand, poor coping skills are a risk factor for depressive symptoms, as the individual fails to overcome hardship [20]. Our findings suggest that depressive symptoms may be an essential component of the mechanism between poorer coping skills and restricted out-of-home mobility. However, future studies should examine whether depressive symptoms mediate this association or whether they directly affect coping and out-of-home mobility.

Hardly any previous knowledge exists on the association of TGP and FGA with mobility. However, it has been found that older people who strive for personal goals tend to move across a wider life-space [17], as was also demonstrated in the present study. Previously, TGP and FGA have mainly been studied in relation to psychological outcomes, such as life satisfaction and depression, and it has been suggested that flexibility is the more important factor for well-being in old age [18, 33]. However, the results of this study indicate that low tenacity, regardless of moderate flexibility, coincides with restricted life-space mobility. Thus, flexibility may function as an important resource for supporting sense of autonomy by helping adjustment to decreased outdoor mobility, while persistency may be more important for maintaining actual mobility and participation in community-life outside the home even when facing functional decline.

Earlier research has focused on studying FGA and TGP separately, even though they typically operate simultaneously in real-life situations [20]. Consequently, little knowledge exists on different coping profiles. Bailly et al. [21] identified the same three coping profiles, high TGP and high FGA, moderate TGP and low FGA, and low TGP and moderate FGA, as we did. We, however, found a fourth profile comprising those low in both TGP and FGA. This supports a recent finding indicating that those with low FGA are also likely to have low TGP [36]. Moreover, our participants were older than those studied by Bailly et al. [21] and interestingly, the participants in our cluster characterized by low tenacity and flexibility had the highest mean age (85.0 years). However, the suggested number of clusters was not perfectly stable, since one of the five analyses yielded only the first three profiles and not the fourth profile of low tenacity and low flexibility. This finding indicates the need for further research on coping profiles.

To our knowledge, this was the first study of coping strategies in relation to life-space mobility and perceived autonomy in participation outdoors. Thus, our findings contribute to the literature on the factors underlying out-of-home mobility in old age. We studied older people aged 79–93 years, since this is usually the time of life when people start to experience functional decline, which may limit their potential to achieve desired goals. We also studied TGP and FGA together as coping profiles, an approach that has rarely been taken hitherto. Another strength of this study was the population-based sample of community-dwelling older people without severe cognitive impairment and representative of all social strata. Data were collected with face-to-face interviews and missing values were few. Furthermore, we considered fundamental theory-based confounders in the analyses, and thus were able to examine whether physical or cognitive limitations, environmental barriers, and depressive symptoms affect the associations.

This study has also its limitations. The analyses were conducted in a cross-sectional dataset, and we were unable to investigate the temporal or causal relationships between the coping profiles and out-of-home mobility. Consequently, even though it is likely that active use of coping strategies underlies different aspects of outdoor mobility, we cannot be certain of that. Future studies should address the temporal associations and clarify which one is the predictor and which one is the outcome using a longitudinal study design. Furthermore, the coping profile of low TGP and low FGA was especially small, rendering it vulnerable to adjustments. Another limitation is that we assessed actual mobility behavior with self-report. However, the life-space mobility measure is well-established and validated [6, 10] and we took objectively measured confounders into account in the analyses, an approach that may enhance the validity of the findings. Finally, we did not use the short TGP and FGA scales in full, but removed the inversely phrased items as their validity has been found to be rather weak among older people [25].

Conclusion

In old age, active use of both tenacious goal pursuit and flexible goal adjustment as coping strategies is beneficial for out-of-home mobility. Persistent goal pursuit, especially, seems to drive older people to participate in meaningful activities and community-life outside the home. In contrast, lack of tenacity and flexibility may restrict out-of-home mobility, a situation that is potentially explained by a higher prevalence of depressive symptoms. Future studies should investigate whether tenacious goal pursuit and flexible goal adjustment can predict changes in life-space mobility or in perceived autonomy in participation outdoors and whether they can be supported to promote out-of-home mobility among older people.

Acknowledgements Open access funding provided by University of Jyväskylä (JYU). The Gerontology Research Center is a joint effort between the University of Jyväskylä and the University of Tampere.

Funding This work was supported by the European Research Council [Grant number 693045 (TR)]; the Academy of Finland [Grant number 255403 (TR)]; and the Ministry of Education and Culture [Grant number OKM/78/626/2014 (TR)]. The financial sponsors had no role in the design, implementation, analyses, or reporting of the results.

Compliance with ethical standards

Conflict of interest The authors declare no conflict of interest.

Statement of human and animal rights The Ethical Committee of the University of Jyväskylä approved the study protocol on September 17, 2015.

Informed consent All participants signed informed consents before the assessments.

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III

PSYCHOLOGICAL RESILIENCE AND ACTIVE AGING AMONG OLDER PEOPLE WITH MOBILITY LIMITATIONS

by

Siltanen S., Tourunen A., Saajanaho M., Palmberg L., Portegijs E. & Rantanen T. 2020.

European Journal of Ageing

DOI: https://doi.org/10.1007/s10433-020-00569-4

European Journal of Ageing
https://doi.org/10.1007/s10433-020-00569-4

ORIGINAL INVESTIGATION

Psychological resilience and active aging among older people with mobility limitations

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Abstract

Active aging refers to striving for well-being through preferred activity and may be restricted with declining mobility. We investigated whether psychological resilience, i.e., the ability to tolerate hardship, can aid older people in being active despite mobility limitations. Participants were 961 community-dwelling persons aged 75, 80, or 85 years living in Jyväskylä, Central Finland. Mobility limitations were indicated as self-reported difficulty in walking 2 km. Categories were no difficulty (reference), difficulty, and unable to walk. Resilience was assessed with the 10-item Connor–Davidson Resilience Scale and active aging with the University of Jyvaskyla Active Aging scale. Data were analyzed with OLS regression analyses, which were stratified by age. In all age-groups, having difficulties walking or being unable to walk 2 km was associated with lower active aging scores. Resilience moderated this association especially among the 75-year-olds, but not among the 85-year-olds: The higher the resilience score, the higher the active aging score among those reporting no or some walking difficulties. Those unable to walk 2 km had lower active aging scores irrespective of resilience level. Psychological resilience may alleviate the negative effects of early phase walking difficulties on active aging but may be insufficient to compensate for more severe walking limitations that restrict not only function but also autonomy.

Keywords Coping · Adaptation · Walking · Participation · Successful aging

Introduction

Gerontology no longer views aging solely as a time of disease and disability. Studies have approached aging well through several, somewhat overlapping, concepts such as successful, healthy, or active aging. In the MacArthur model, features of successful aging include maintaining good physical health, good mental and physical function, and active engagement with life (Rowe and Kahn 1987). Although being one of the most ubiquitous models of aging well, it has also been criticized for being too exclusive and correlating poorly with older people's perceptions of aging well (McLaughlin et al. 2012; Pruchno and Carr 2017; Rowe and Kahn 1987, 2015; Strawbridge et al. 2002). Drawing on the activity and self-determination theories (Havighurst 1961; Ryan and Deci 2000), the World Health Organization (WHO) set out the active aging policy framework (World Health Organization 2002). The framework emphasizes opportunities for participation in activities that correspond to the rights, goals, needs, and capacities of people as they age. It is also more inclusive and considers older people's own voices. However, since the WHO framework is designed to guide policies and societal actions, researchers have been unable to use it to model individual-level data (Bélanger et al. 2017; Paúl et al. 2012).

Drawing on the WHO framework, we recently defined active aging of individuals as "the striving for elements of wellbeing through activities relating to a person's goals, functional capacities and opportunities"(Rantanen et al. 2019). Our viewpoint includes activity and ability but also the will to act and overall opportunities for activity. As personal preferences are in a key role, active aging may manifest in various ways. Hence, for empirical purposes,

Responsible editor: Matthias Kliegel.

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s10433-020-00569-4) contains supplementary material, which is available to authorized users.

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we created and validated a quantitative self-rating scale (Rantanen et al. 2019) that incorporates several essential life areas in line with the categories of Activities and Participation of the International Classification of Functioning, Disability and Health (ICF) (World Health Organization 2001). Higher active aging scores were found to correlate with better quality of life and perceived health and autonomy and with greater life-space mobility (Rantanen et al. 2019), which is an indicator of community mobility and participation. To understand these associations better, the factors influencing and underlying active aging merit further investigation.

Difficulty walking longer distances is a common adversity among older people and typically the first sign of functional decline, which may eventually progress to inability and even difficulty with shorter distances (Mänty et al. 2007; Rantanen 2013; Verbrugge and Jette 1994). Walking difficulties make leaving the home and accessing local amenities and activities more burdensome (Rantakokko et al. 2013; Rantanen 2013). Hence, they may further increase the risk for reduced life-space mobility and eventually lead to the abandonment of valued activities outside the home (Rantakokko et al. 2017). Nevertheless, some older persons are able to remain active and maintain relatively higher level of outdoor mobility despite walking difficulties (Morrow-Howell et al. 2014; Rantakokko et al. 2017) and may thus possess some other, possibly psychological, resources. We recently reported that tenacity and flexibility in goal pursuit are associated with higher life-space mobility and perceived autonomy in participation outdoors (Siltanen et al. 2019) and that tenacious older persons are more likely to engage in leisure time activities in the face of physical decline than less tenacious counterparts (Tourunen et al. 2019a). Tenacity and flexibility relate to psychological resilience, which refers to the ability to adapt positively to adversity and overcome stressful situations (Dyer and McGuinness 1996).

Psychological resilience may enable people to maintain a higher level of activity regardless of walking difficulty and thus contribute to active aging of individuals. Resilience has been characterized as a dynamic process underlying individual differences in response to life hazards (Luthar et al. 2000; Rutter 2006) and as a more stable personal trait manifesting even in the absence of a stressful situation (Luthar et al. 2000). Resilience has also been described by its attributes, such as high self-efficacy in specific tasks and situations (Gillespie et al. 2007; Hicks and Conner 2014). It is commonly agreed, however, that resilience contributes to well-being and quality of life when confronting adversities and hence may be a key resource for aging well. Some previous studies have shown that higher levels of resilience are associated with higher levels of physical activity (Perna et al. 2012; Resnick et al. 2018) and social participation (Levasseur et al. 2017). However, it is unclear whether resilience contributes to active aging among people facing mobility impairments.

This study examined (1) the associations of active aging with difficulties in walking 2 km and psychological resilience, and (2) whether resilience moderates the association between walking difficulties and active aging among community-dwelling people aged 75, 80, and 85 years. We hypothesized that walking difficulties increase the likelihood of lower active aging scores and that higher resilience mitigates this association. We also assumed that such mitigation would likely depend on the severity of walking difficulty and age.

Methods

Data and participants

The present analyses form part of the *Active aging—resilience and external support as modifiers of the disablement outcome* (AGNES) study. Details of the design and protocol have been reported elsewhere (Rantanen et al. 2018). Briefly, AGNES is a population-based, observational study of three age cohorts (75, 80, and 85 years) conducted at the University of Jyväskylä, Finland. Based on power calculations, a sample size of 1000 persons was needed to provide a 99% power to demonstrate a contribution to the explained variance of 5% in a linear regression model with 10 predictors. A sample of 2791 community-dwelling older persons living in the Jyväskylä area in Central Finland was drawn from the national population register. Of these, 2348 persons were reached and informed about the study. All those willing to participate and able to communicate with the interviewers were included in the study ($N = 1021$) (Portegijs et al. 2019). For this study, data were collected between 2017 and 2018 via computer-assisted, face-to-face interviews in the participants' homes ($n = 1018$). The present analyses were performed only for participants with data on active aging, walking difficulties, and psychological resilience ($n = 961$). Of these, 557 were women and 404 were men, and 46% were aged 75, 33% aged 80, and 21% aged 85.

All participants signed a written informed consent. The study protocol was approved by the Central Finland Health Care District on August 23, 2017.

Variables

Active aging was assessed using the University of Jyväskylä Active Aging Scale (UJACAS) (Rantanen et al. 2019). The UJACAS scale consists of 17 activity items: practicing memory, using a computer, advancing matters in one's own life, exercising, enjoying the outdoors, taking care of one's personal appearance, crafting or DIY, making one's home cozy and pleasant, helping others, maintaining friendships, getting to know new people, balancing personal finances, making one's days interesting, practicing artistic hobbies, participating in events, advancing societal/communal matters, and doing things in accord with one's world view. Each activity is assessed from four perspectives: willingness (to what extent the person wants to do the activity), ability (to what extent the person is able to do it), opportunity (to what extent the person perceives opportunities to do it), and activity (how often or how much the person does it). Respondents were asked to assess each item with respect to the past 4 weeks and give an answer on a five-point Likert scale ranging from 0 (lowest) to 4 (highest). The response options are worded to suit the items, for example from "not at all" to "daily or almost daily" for activity and from "not at all" to "very strongly" for willingness. The scores were summed to form, first, four subscores (willingness, ability, opportunity, activity; range 0–68 in each) and second, for participants with at most two missing items in each subscore, a total score (range 0–272). The following formula was used to impute missing data: (sum score/items responded to) x items offered. Higher scores indicate a higher level of active aging. The reliability and validity of the measure are good (Rantanen et al. 2019).

Walking difficulties were assessed based on validated self-reports (Mänty et al. 2007). Participants were asked whether they were able to walk 2 km. The response options were "able without difficulty," "able with some difficulty," "able with a great deal of difficulty," "unable without the help of another person," and "unable to manage even with help." To reduce the number of dimensions, walking difficulties were recoded into three categories: no difficulty, some or a great deal of difficulty, and unable to walk 2 km (with or without the help of another person). Those reporting no difficulties in walking formed the reference category.

Psychological resilience was assessed with a slightly modified, shortened version of the Connor–Davidson Resilience Scale (CD-RISC), which showed good validity and acceptable reliability in the AGNES sample (Tourunen et al. 2019b). Unlike in the original scale, which refers to the previous 4 weeks, we asked the participants to consider their life in general when responding. The shortened scale consists of ten items that reflect the respondent's ability to tolerate and bounce back from a variety of challenges in life, e.g., "can deal with whatever comes," "can achieve goals despite obstacles," and "not easily discouraged by failure" (Campbell-Sills and Stein 2007). The 5-point Likert response scale ranges from not true at all (0) to true nearly all of the time (4). A sum score was calculated (range 0–40, higher scores indicating more resilience) when at least seven items received a response. For the 12 participants who had 1–3 missing items, we imputed new values based on the means of their existing values. In addition, 48 (4.7%) participants had more than three missing items and were not included in the analyses. For sensitivity analysis, resilience was classified into tertiles: highest (≥ 34), middle (33–30), and lowest (≤ 29).

Covariates Age, sex, morbidity, education, living alone, and cognitive function were set as covariates, since they correlated with at least one of the predictors and/or outcome (Supplementary Table 1). Age and sex were drawn from the national population register. The number of years of education was self-reported (Rantanen et al. 2019). In line with our previous studies (Rantanen et al. 2012), morbidity was indicated by the number of self-reported physician-diagnosed chronic diseases calculated based on a list of 34 common conditions and an open-ended additional question. Living alone (yes vs. no) was assessed with the question: "Who do you live with?" Global cognitive function was measured with the Mini-Mental State Examination (MMSE) (Folstein et al. 1975).

Statistical analyses

Participants' characteristics were described with means and standard deviations (continuous variables) or with percentages (categorical variables). Differences between age-group means or proportions were tested with one-way ANOVA and Bonferroni post hoc test or Chi square test, respectively. To learn whether it would be reasonable to stratify the main analyses by age-group and/or sex, we executed ordinary least squares (OLS) regression analyses in which interactions between age, sex, resilience, and walking difficulties with active aging as outcome were tested. Next, the individual associations of walking difficulties and resilience with active aging were tested with unadjusted OLS models that included only one or the other as an independent variable. Secondly, walking difficulties and resilience were added to the model simultaneously as independent variables. In the final step, walking difficulties and resilience were allowed to interact to test whether resilience moderates the relationship between walking difficulties and active aging. Walking difficulty was coded as multicategorical by using the indicator method. To probe the moderation effect, a pick-a-point approach by regression centering was used with the 16th, 50th, and 84th percentiles of the distribution of the resilience scale describing relatively low, moderate, and relatively high values (Hayes 2017). The moderation analyses were first unadjusted, after which the covariates were added one at a time, and eventually, simultaneously. The analyses were age-stratified.

Finally, as a sensitivity analysis, we tested whether those reporting difficulties walking 2 km in the highest resilience tertile differed in their activity from those reporting difficulties walking 2 km in the lowest resilience tertile. Group differences in the UJACAS activity subscores (continuous variable) were tested with independent samples t test and in the separate activity items (categorical variables) with Chi square test. All analyses were performed with SPSS Statistics 24 for Windows. The PROCESS macro version 3.3 for SPSS was utilized for the moderation analyses (Hayes 2017).

Results

Table 1 describes the study participants' characteristics. Active aging scores were lower, and self-reported walking difficulties or inability to walk 2 km was more common among the 85-year-olds than among the younger participants (Table 1). A declining age gradient was observed for length of education, cognitive function, and number of chronic conditions. Living alone was more common among the older participants. Resilience did not differ by age. Those reporting no difficulty walking 2 km had more favorable values in all variables when compared to those reporting difficulties or inability to walk 2 km. In addition, walking difficulties were reported more frequently by women than men.

We stratified the main analyses by age-group, as the preliminary OLS analyses indicated that age moderated the associations between resilience and active aging and between walking difficulty and active aging ($p = 0.005$ and $p = 0.02$, respectively). The interactions between sex and walking difficulty and between sex and resilience with the active aging score as outcome were not statistically significant (Supplementary Table 2).

Individually, walking difficulties and resilience accounted for a considerable proportion of the variance of active aging in all three age-groups (Table 2). When compared with those reporting no difficulties in walking 2 km, those reporting walking difficulties or inability to walk 2 km showed lower active aging scores. Higher resilience, in turn, was associated with higher active aging scores. Adding these variables to the model simultaneously did not markedly change the results, except for the 75-year-olds, among whom the relationship between walking difficulties and active aging became nonsignificant.

Moderation effect

Further analysis showed that the interaction of resilience and difficulty walking 2 km with active aging as outcome was significant among the 75- and 80-year-olds. Higher resilience was associated with higher active aging scores for those with no difficulty walking 2 km and for those with difficulty walking 2 km, but not for those reporting inability to walk 2 km

Table 1 Background characteristics of the study participants by age-group and 2 km walking category

	Age				2 km walking difficulties			
	75 yrs $n = 457$	80 yrs $n = 334$	85 yrs $n = 227$		No difficulty $n = 634$	Difficulty $n = 284$	Unable $n = 76$	
	Mean (SD)	Mean (SD)	Mean (SD)	*p*	Mean (SD)	Mean (SD)	Mean (SD)	*p*
Years of education	12.1 (4.2)	11.7 (5.3)	10.2 (4.1)	< .001[a]	11.8 (4.3)	11.5 (5.3)	10.1 (4.3)	.013[a]
Number of chronic conditions	3.2 (2.1)	3.4 (2.0)	3.9 (2.0)	< .001[a]	2.9 (1.7)	4.3 (2.1)	4.8 (2.6)	< .001[a]
Cognitive function (MMSE)	27.6 (2.3)	27.1 (2.7)	26.2 (2.8)	< .001[a]	27.3 (2.4)	27.1 (2.3)	25.4 (3.4)	< .001[a]
Active aging (UJACAS)	200.5 (28.5)	194.0 (31.4)	177.4 (34.0)	< .001[a]	202.3 (26.5)	186.0 (31.1)	150.9 (33.6)	< .001[a]
Resilience (CD-RISC10)	31.4 (5.0)	31.0 (5.2)	30.8 (5.6)	.250[a]	31.6 (4.9)	30.4 (5.5)	29.6 (5.9)	< .001[a]
Women (%)	57.8	55.7	58.6	.760[b]	53.2	66.2	61.8	.001[b]
2 km walking difficulties (%)				< .001[b]	–	–	–	–
No difficulty	73.6	62.5	45.4					
Difficulties	21.1	31.7	39.4					
Unable	5.3	5.8	15.1					
Living alone (%)	33.3	38.9	60.4	< .001[b]	34.4	50.4	63.2	< .001[b]

SD standard deviation, *MMSE* mini-mental state examination, *SPPB* short physical performance battery, *CD-RISC10* 10-item Connor–Davidson Resilience Scale, *UJACAS* University of Jyvaskyla Active Aging Scale

[a]Tested with one-way ANOVA, [b]Tested with Chi square

Table 2 The individual associations of 2 km walking difficulties (reporting walking difficulty or being unable to walk independently vs. reporting no difficulty) and resilience (CD-RISC10, range 0–40) with active aging (UJACAS, range 0–272) tested with OLS regression analysis

	Model 1			Model 2			Model 3		
	B	95% CI	R^2	*B*	95% CI	R^2	*B*	95% CI	R^2
75-year-olds	*n = 450*			*n = 447*			*n = 445*		
No difficulty	0.0	Ref.	0.19	–	–	–	0.0	Ref.	0.26
Walking difficulty	− 6.38	− 12.27, − 0.49		–	–	–	− 5.01	− 10.62, 0.59	
Unable to walk	− 55.14	− 65.83, − 44.45		–	–	–	− 51.65	− 61.95, − 41.36	
Resilience	–	–	–	1.74	1.24, 2.23	0.10	1.58	1.13, 2.03	0.26
80-year-olds	*n = 325*			*n = 323*			*n = 319*		
No difficulty	0.0	Ref.	0.20	–	–	–	0.0	Ref.	0.39
Walking difficulty	− 19.83	− 26.44, − 13.22		–	–	–	− 17.09	− 22.90, − 11.29	
Unable to walk	− 51.23	− 63.34, − 38.12		–	–	–	− 40.04	− 51.79, − 28.29	
Resilience	–	–	–	3.07	2.50, 3.63	0.26	2.75	2.23, 3.27	0.39
85-year-olds	*n = 214*			*n = 199*			*n = 197*		
No difficulty	0.0	Ref.	0.15	–	–	–	0.0	Ref.	0.33
Walking difficulty	− 15.60	− 24.89, − 6.32		–	–	–	− 10.84	− 19.42, − 2.26	
Unable to walk	− 39.32	− 51.90, − 26.74		–	–	–	− 36.00	− 48.32, − 23.67	
Resilience	–	–	–	2.86	2.11, 3.61	0.22	2.63	1.91, 3.34	0.33

Model 1 included only walking difficulties as an independent variable. Model 2 included only resilience as an independent variable. Model 3 included both walking difficulties and resilience as independent variables. All models were unadjusted. The association is statistically significant if the 95% confidence interval does not include zero

(Table 3). The moderation effect was statistically significant at all probed levels of resilience ($p < 0.001$ for all) and remained significant among the 75-year-olds in all the adjusted models. Among the 80-year-olds, the moderation effect was no longer statistically significant in the fully adjusted model, since adjusting for cognitive function attenuated the associations to the point where they became nonsignificant. The unadjusted moderation effects are illustrated in Figs. 1 (75-year-olds) and 2 (80-year-olds). Among the 85-year-olds, the moderation effect was not statistically significant.

Sensitivity analysis

Those reporting difficulties walking 2 km in the highest resilience tertile ($n = 88$) had higher UJACAS activity subscores than those reporting difficulties walking 2 km in the lowest resilience tertile ($n = 115$; mean 43.4, SD 7.9 vs. *M* 34.8, SD 9.0, respectively, $p < 0.001$). In addition, those with higher resilience were more active, e.g., in practicing memory, advancing matters in one's own life, making one's home cozy and pleasant, maintaining friendships, balancing personal finances, making one's days interesting, and doing things in accord with one's world view (χ^2 $p \leq 0.001$) than those in the lowest resilience tertile and reporting difficulties walking 2 km. In contrast, the groups showed no differences in participation in events, helping others or exercising.

Discussion

These findings establish a novel approach to research on aging well. To our knowledge, this is the first study to show that higher psychological resilience may contribute to active aging among persons with early phase mobility limitations. However, it seems that while psychological resilience may compensate for the negative impact of declining walking ability in its early phase, it no longer has such mitigating effect in the more severe phase of mobility decline.

Information on the association of psychological resilience with functioning of older people has been rather limited. It was only recently found that, despite mobility limitations, older people with high tenacity are more likely to participate in leisure activities (Tourunen et al. 2019a, b) and that those with high tenacity and flexibility are more likely to maintain higher extent and autonomy in outdoor mobility (Siltanen et al. 2019). Tenacity and flexibility in goal pursuit may be considered attributes of resilience. In addition, an earlier study reported that higher

Table 3 Age-stratified ordinary least squares path analyses with psychological resilience (CD-RISC10, range 0–40) as a moderator of the relationship between 2 km walking difficulties (reporting walking difficulty or being unable to walk independently vs. reporting no difficulty) and active aging (UJACAS, range 0–272)

	Unadjusted model				Fully adjusted model			
	B	S.E.	*p*	95% CI	*B*	S.E.	*p*	95% CI
75-year-olds	*n* = *445*				*n* = *443*			
No difficulty	0.0	Ref.	Ref.	Ref.	0.0	Ref.	Ref.	Ref.
Walking difficulty	4.48	17.01	0.79	− 28.96, 37.91	12.62	15.93	0.43	− 18.69, 43.94
Unable to walk	18.49	27.06	0.50	− 34.71, 71.68	26.10	25.57	0.31	− 24.17, 76.36
Resilience (Res.)	1.83	0.28	< 0.001	1.28, 2.37	1.90	0.26	< 0.001	1.38, 2.41
No difficulty * Res.	0.0	Ref.	Ref.	Ref.	0.0	Ref.	Ref.	Ref.
Difficulty * Res.	− 0.30	0.54	0.58	− 1.36, 0.76	− 0.48	0.50	0.34	− 1.47, 0.51
Unable to walk* Res.	− 2.32	0.88	0.009	− 4.04, − 0.59	− 2.25	0.83	0.007	− 3.88, − 0.62
80-year-olds	*n* = *319*				*n* = *317*			
No difficulty	0.0	Ref.	Ref.	Ref.	0.0	Ref.	Ref.	Ref.
Walking difficulty	− 17.20	17.43	0.32	− 51.29, 17.10	− 22.54	16.44	0.17	− 54.89, 9.82
Unable to walk	41.36	35.68	0.25	− 28.85, 111.58	13.87	33.98	0.68	− 52.99, 80.72
Resilience (Res.)	2.89	0.34	< 0.001	2.22, 3.56	2.66	0.32	< 0.001	2.03, 3.29
No difficulty * Res.	0.0	Ref.	Ref.	Ref.	0.0	Ref.	Ref.	Ref.
Difficulty * Res.	0.01	0.56	0.99	− 1.09, 1.10	0.16	0.53	0.76	− 0.88, 1.20
Unable to walk* Res.	− 2.87	1.23	0.021	− 5.31, − 0.44	− 1.69	1.18	0.15	− 4.01, 0.63
85-year-olds	*n* = *197*				*n* = *195*			
No difficulty	0.0	Ref.	Ref.	Ref.	0.0	Ref.	Ref.	Ref.
Walking difficulty	− 29.00	24.97	0.25	− 78.25, 20.25	− 36.62	24.05	0.13	− 84.06, 10.83
Unable to walk	− 9.11	32.42	0.78	− 73.07, 54.84	− 18.23	31.92	0.57	− 81.21, 44.75
Resilience (Res.)	2.53	0.57	< 0.001	1.40, 3.65	2.34	0.55	< 0.001	1.25, 3.42
No difficulty * Res.	0.0	Ref.	Ref.	Ref.	0.0	Ref.	Ref.	Ref.
Difficulty * Res.	0.60	0.80	0.45	− 0.97, 2.17	0.94	0.77	0.22	− 0.57, 2.46
Unable to walk* Res.	− 0.90	1.04	0.39	− 2.94, 1.15	− 0.32	1.02	0.75	− 2.33, 1.68

The fully adjusted model was adjusted for sex, years of education, cognitive function, number of chronic conditions, and living alone

levels of resilience prevented ADL and IADL disability at the onset of a new chronic condition (Manning et al. 2014). The present findings are the first to show the importance of resilience for active aging measured with a novel instrument incorporating will, ability, and opportunity to act, and the level of activity in 17 activities describing active agency in essential life areas (Rantanen et al. 2018).

Difficulty in walking longer distances is one of the most common adversities that older people face. In our sample, over one-third overall and over half of the 85-year-olds reported at least some difficulties in walking 2 km. The present findings suggest that resilience may mitigate the negative effects of walking difficulties on active aging. An important aspect of resilience is being determined and persistent in one's personal aspirations (Lamond et al. 2008) and possibly coming up with new ways to attain them. This may be a plausible explanation for our finding. For example, persons with high resilience may compensate for their mobility limitations by applying adaptive strategies (e.g., assistive devices, slowing down the pace of walking, taking rest breaks), which have been shown to help maintain greater life-space mobility and autonomy in participation in out-of-home activities (Skantz et al. 2020). Active use of compensatory strategies among persons with reduced physical function and high well-being has also been reported elsewhere (Carpentieri et al. 2017).

Another possible explanation for the finding that resilience supports active aging among people at the early phase of mobility decline may be that we studied a comprehensive range of essential life activities. Our idea was to include items that cover a variety of activities of older people and are, in principle, also feasible for people with disabilities (Rantanen et al. 2019). Thus, the items do not have strict objective criteria but are worded to allow the participants themselves to define what the activity involves. For example, for some people the item "maintaining friendships" may mean joint walks and coffee dates, while for others it may mean a phone call. People with walking difficulties and high resilience may strive to engage in their valued activities in ways that better correspond to their declined mobility. For

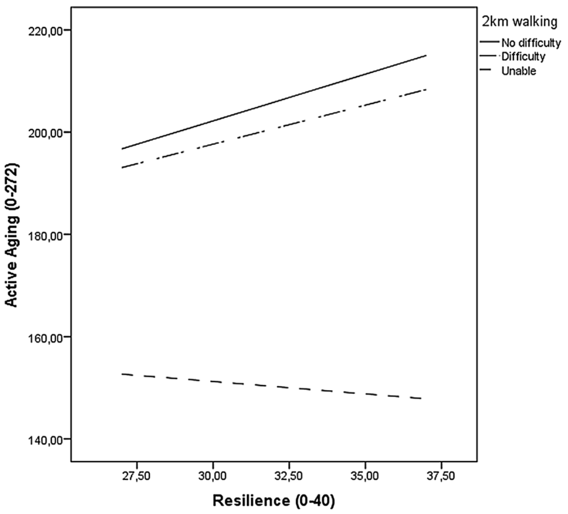

Fig. 1 Illustration of the unadjusted OLS path analysis with psychological resilience (CD-RISC10) as a moderator of the relationship between 2 km walking difficulties (reporting walking difficulty or being unable to walk independently vs. reporting no difficulty) and active aging (UJACAS) among the 75-year-olds (n = 445). *Note* Fit for model $R^2 = 0.27$, $F(5, 439) = 32.80$, $p < 0.001$. The moderation effect was probed using regression centering with the 16th, 50th, and 84th percentiles of the distribution of the resilience scale describing relatively low, moderate, and relatively high values. The effect was significant at all these levels ($p < 0.001$)

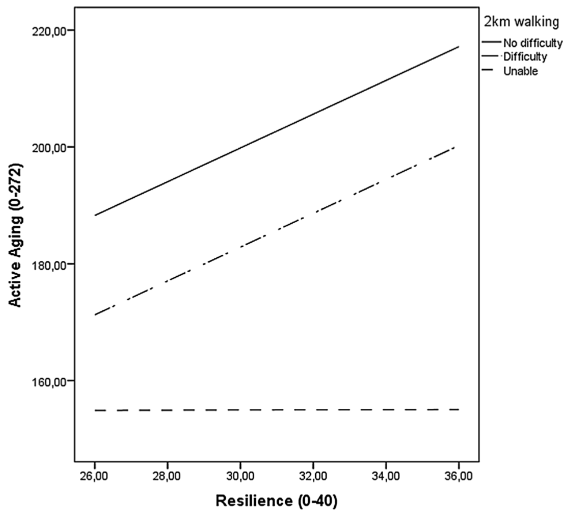

Fig. 2 Illustration of the unadjusted OLS path analysis with psychological resilience (CD-RISC10) as a moderator of the relationship between 2 km walking difficulties (reporting walking difficulty or being unable to walk independently vs. reporting no difficulty) and active aging (UJACAS) among the 80-year-olds (n = 319). *Note* Fit for model $R^2 = 0.41$, $F(5, 313) = 42.78$, $p < 0.001$. The moderation effect was probed using regression centering with the 16th, 50th, and 84th percentiles of the distribution of the resilience scale describing relatively low, moderate, and relatively high values. The effect was significant at all these levels ($p < 0.001$)

example, they may increase their participation in activities closer to home that make less demands on mobility, rather than giving up on them completely. Our sensitivity analyses showed that these persons were more active, e.g., in practicing memory, balancing finances, making one's home cozy and maintaining friendships, i.e., in activities that can be performed at home even in the presence of physical limitations.

The findings also indicated that in cases of more advanced mobility limitations, operationalized in this study as the inability to walk 2 km, resilience might lose its mitigating effect. Mobility decline often co-occurs with other functional and health deficits, such as cognitive decline (Atkinson et al. 2005; Clouston et al. 2013; Demnitz et al. 2016) and depression (Milaneschi and Penninx 2014; Thorpe Jr et al. 2011), which may further lessen a person's striving to engage in various important life areas. Here, those unable to walk 2 km had significantly lower MMSE scores than those in the other walking categories. In addition, being unable to walk 2 km independently may be experienced as such a drastic loss of function, and especially of autonomy, that positive psychological adaptation alone cannot compensate for it. Compared to persons with some walking difficulties, those unable to walk have fewer personal resources and are more dependent on help and support from others (Rantanen 2013). In our sample, those unable to walk 2 km were also most likely to have trouble walking 500 m. Lastly, the resilience scores clustered toward the lower end of the scale among persons reporting inability to walk 2 km. Thus, testing the moderation effect with relatively high values for resilience might have made it hard to detect a significant association as, in reality, only a few participants unable to walk 2 km demonstrated a very high level of resilience.

Finally, we observed no difference between the three age-groups in resilience. Typically, decline in health and functioning accelerates after age 60, and many major changes take place after age 80 (Ferrucci et al. 2016). However, the present finding indicates that, unlike many other personal resources, resilience does not decline with advancing age. Earlier studies have also found that psychological resilience is as high or even higher in older than in young or middle-aged persons (Gooding et al. 2012; Hamarat et al. 2002). This finding supports suggestions that resilience is an essential factor for adapting to aging and for aging well (Hayman et al. 2017).

The roles and functions of resilience may, however, differ in different stages of old age. In this study, resilience was associated with active aging among all age-groups, even when controlling for walking difficulties, yet the moderation effect was robust only among the 75-year-olds. As discussed by Hayman et al. (2017), the oldest-old with high resilience tend to shift their focus onto what they still can rather than cannot do when they confront age-related adversities. Hence, in line with the model of selection, optimization and compensation (Baltes 1997), the oldest-old may focus on selecting and retaining the most meaningful of their activities when facing mobility decline, while the younger-old may be more active in creating compensatory strategies that enable them to continue various activities. Successful compensation requires sufficient resources (Ebner et al. 2006; Saajanaho et al. 2016). This may render the cost–benefit ratio of compensatory efforts unfavorable or compensatory activities no longer possible for the oldest old (Baltes and Smith 2003; Rothermund and Brandstädter 2003), who may lack socioeconomic resources and not see it as realistic to strive for high activity compared to the young-old (Saajanaho et al. 2016). After all, loss-based selection, i.e., focusing on fewer goals, may result in an equally meaningful life and positive adaptation among the 85-year-olds but manifest as lower active aging scores. Other explanations for the nonsignificant moderation effect may be the smaller sample sizes among the oldest-old and early phase cognitive decline, which attenuated the associations among the 80-year-olds.

Strengths of the study

This study lays a foundation for new, more comprehensive and interdisciplinary hypotheses on the factors underlying active aging. The present approach to aging well also applies to individuals with functional limitations and disability and considers older people's own preferences. In addition, the present 17-item measure of active aging may capture the phenomenon of active aging in its various forms as older people may be equally *active* but perform very diverse activities. Moreover, this study was population-based and included a large sample of men and women within the age range most vulnerable to functional decline. Further strengths of the study were the utilization of a novel measure of active aging and reporting on a topic with limited prior data.

Study limitations

The present cross-sectional design does not allow the investigation of causation. Thus, we cannot be certain which factors are predictors and which are outcomes, and whether active aging can be influenced by promoting resilience and mobility. These are issues that await future studies. Another limitation of the study is that, while most likely applicable to western cultures, our findings are not necessarily applicable to other cultures and populations, as resilience may be culture-specific (Tourunen et al. 2019a, b). Moreover, the participants' resilience scores were rather high in general, and hence, our findings may underestimate the effects of resilience on active aging.

Conclusions

High levels of psychological resilience may alleviate the negative effects of walking difficulties on active aging. However, high levels of resilience may not fully compensate for more severe impairment in walking ability. Future studies should continue this work by addressing the longitudinal and causal associations between mobility decline, resilience, and active aging to find out whether promoting resilience and mobility would also enhance active aging.

Acknowledgements Open access funding provided by University of Jyväskylä (JYU). The Gerontology Research Center is a joint effort between the University of Jyväskylä and the University of Tampere.

Funding This work was supported by the European Research Council (Grant Number 693045 to TR) and the Academy of Finland (Grant Number 310526 to TR). The funders had no role in designing and implementing the study or reporting the analyses. The content of this paper does not reflect the official opinion of the European Union. Responsibility for the information and views expressed in the paper lies entirely with the authors.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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IV

EFFECTS OF AN INDIVIDUALIZED ACTIVE AGING COUNSELING INTERVENTION ON MOBILITY AND PHYSICAL ACTIVITY: SECONDARY ANALYSES OF A RANDOMIZED CONTROLLED TRIAL

by

Siltanen S., Portegijs E., Pynnönen K., Hassandra M., Rantalainen T., Karavirta L., Saajanaho M. & Rantanen T. 2020.

Journal of Aging and Health

DOI: https://doi.org/10.1177/0898264320924258

Article

Journal of Aging and Health
2020, Vol. 0(0) 1–9

DOI: 10.1177/0898264320924258
journals.sagepub.com/home/jah
SAGE

Effects of an Individualized Active Aging Counseling Intervention on Mobility and Physical Activity: Secondary Analyses of a Randomized Controlled Trial

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Abstract

Objectives: The aim of this study was to report preplanned secondary analyses of the effects of a 12-month individualized active aging counseling intervention on six mobility and physical activity outcomes. **Methods:** A two-arm, single-blinded randomized controlled trial was conducted among 75- and 80-year-old community-dwelling people. The intervention group (IG, n = 101) received counseling aimed at increasing self-selected, primarily out-of-home activity. The control group (CG, n = 103) received general health information. Data were analyzed with generalized estimating equations. **Results:** Physical performance improved in the IG more than that in the CG (group by time p = .022), self-reported physical activity increased in both groups (time p = .012), and autonomy in outdoor mobility declined in the IG and was enhanced in the CG (group by time p = .011). No change was observed for life-space mobility, proportion of persons perceiving difficulty walking 2 km, or monitored physical activity. **Discussion:** Individualized counseling aiming at increasing self-selected out-of-home activity had nonsystematic effects on mobility and positively affected physical performance only.

Keywords

meaningful activity, physical function, life-space, autonomy, randomized controlled trial

Introduction

Mobility and physical activity (PA) are closely intertwined with many everyday activities of older people, such as making social visits, attending events, shopping, or running errands (Tsai et al., 2016). Increasing participation in any meaningful activity outside the home will likely increase PA and promote mobility in terms of extending life space (Barnes et al., 2007; Saajanaho et al., 2014; Saajanaho et al., 2015). In general, optimal mobility refers to the ability to move oneself safely from one place to another (Satariano et al., 2012) and allows for participation in different activities in a variety of environments. It may be viewed from such diverse perspectives as (1) the ability to perform various tasks such as walk given distances or climb stairs (Mänty et al., 2007), (2) the extent of moving about either on foot or via transportation (Peel et al., 2005), and (3) perceived ability to decide where, when, and how to move, that is autonomy in outdoor mobility (Cardol et al., 1999; Wilkie et al., 2006). These aspects can all be assessed by observing or monitoring participants or by self-reports, and combined, they will provide a more comprehensive understanding of a person's overall mobility.

Greater life-space mobility, describing the spatial area a person moves through in daily life (Baker et al., 2003), correlates with a higher level of PA (Portegijs et al., 2015; Tsai et al., 2015), better physical performance, greater autonomy in outdoor mobility (Portegijs, Rantakokko, Mikkola et al., 2014), and fewer perceived difficulties in walking longer distances (Rantakokko et al., 2017). Viewed the other way round, mobility is a prerequisite for maintaining positive social roles, a good quality of life, and independence in old age (Patla & Shumway-Cook, 1999; Rantakokko et al., 2013; Rantanen, 2013). For example we observed that increased engagement in any out-of-home activity can improve the physical domain of quality of life, even among older people with severe mobility limitations (Rantanen et al., 2015).

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Furthermore, our previous studies have shown that striving for activity-related goals is associated with higher life-space mobility (Saajanaho et al., 2015) and predicts greater exercise activity (Saajanaho et al., 2014). Because people often strive to reach their goals, we expected mobility and PA to be promoted as a "side effect" of increasing the pursuit of any meaningful and self-selected activity that takes place outside the home.

This study reports preplanned secondary analyses of a randomized controlled trial of active aging counseling among community-dwelling older people. The intervention, which centered on supporting the participants' autonomous motivation and goal setting and increasing their awareness of desirable out-of-home activities (Rantanen et al., 2019), enhanced the participants' active aging score, although the effect was small (Rantanen et al., 2020). The aim of the present study was to test whether the individualized counseling intervention also affects physical performance, perceived difficulties in walking 2 km, life-space mobility, perceived autonomy in outdoor mobility, and self-reported and objectively monitored PA. We expected positive changes in the intervention group (IG) and no or smaller changes in the control group (CG), which received general health information by ordinary mail.

Methods

Design and Participants

This study reports preplanned secondary analyses of a community-based two-arm single-blinded randomized controlled trial (ISRCTN16172390), "individualized counseling for active aging—AGNES intervention." The trial has been described in-depth in the study protocol (Rantanen et al., 2019), and the primary outcomes have been reported elsewhere (Rantanen et al., 2020). Briefly, the study participants were community-dwelling older people living in the city of Jyväskylä in Central Finland. The trial comprised two parallel groups: an IG and a CG with a 1:1 allocation ratio. Participants were recruited from among the participants of the AGNES cohort study (Rantanen et al., 2018) between October 2017 and August 2018. The inclusion criteria for the trial were willingness to participate, age 75 or 80 years, a baseline score between 52.3 and 90.0 on the University of Alabama at Birmingham Life-Space Assessment (LSA) (Baker et al., 2003), and a minimum score of 25 on the Mini-Mental State Examination (Folstein et al., 1975). In addition, participants were expected to be able to communicate. These criteria were chosen to include participants who have room for improvement in their activity levels and whose cognitive function enables compliance with the intervention. Persons participating in another ongoing intervention were excluded.

In accordance with the power calculations made for the primary outcome (Rantanen et al., 2019), 101 persons were randomly allocated to the IG and 103 to the CG. The study statistician generated the random allocation sequence with Stata 15.0 statistical software and sealed them in envelopes. Randomization was stratified by age and gender. After the pretrial data collection was completed, the study counselor opened the randomization envelopes. The flowchart of the study was previously published as part of the primary outcome article (Rantanen et al., 2019), and thus appended to this article in Appendix A. Mobility and PA were assessed pretrial (before randomization) and posttrial (at 12 months) by home interviews and activity monitoring in the free-living environment using accelerometers. Interviewers and assessors were blinded to treatment group allocation. A total of 17 persons (n = 10 in the IG and n = 7 controls) dropped out during the trial. Of these, two dropped out immediately after randomization and thus did not receive the intervention. Reasons for dropping out were unwillingness to continue (n = 13), health decline (n = 2), and death (n = 1). In addition, one participant's all follow-up data were damaged.

Intervention

The intervention's aim was to increase self-selected meaningful activity in everyday life. Although the emphasis in the counseling and supportive material was on increasing participation in out-of-home physical and social activities, participants were supported in striving for any goals they found important (Rantanen et al., 2019). To enable personalization of the intervention, participants were profiled according to their baseline health status, social contacts, and the level of well-being, and the counseling protocol then was adjusted to their preferred activities and goals. The counseling approach was based on two major motivational theories: the self-determination theory, which highlights the importance of intrinsic and self-determined rather than external and regulated motivation behind actions (Deci & Ryan, 2000), and the theory of planned behavior, which emphasizes the role of beliefs and intentions as a basis for desirable behavior (Ajzen, 1985).

The intervention included a 90-minutes face-to-face counseling session at the research center at the beginning of the study and four shorter phone counseling sessions at months 1, 3, 6, and 9. The counseling sessions followed a semistructured protocol concerning, for example participants' current activities, goals, and action plans. During the first session, participants were provided with supportive materials, such as an active aging information booklet, a calendar, and a newsletter (Rantanen et al., 2019). The newsletter, featuring information on the activities available in the city of Jyväskylä and stories of other participants' success in experiencing an active life, was updated and sent to the participants every three months during the trial. The subsequent phone counseling sessions provided social support, feedback, and encouragement related to pursuing the selected goals. A trained counselor with previous experience in counseling older adults implemented the intervention.

Control Group

Controls were mailed printed brochures and booklets related to general health at months 1, 3, 6, and 9. Brochures and booklets were obtained from different national public health associations and sorted into four themes: (1) exercise, (2) nutrition, (3) cardiovascular diseases, and (4) type II diabetes.

Measurements

Physical performance. Physical performance was assessed with the Short Physical Performance Battery (SPPB), which includes tests for standing balance (feet together, semi-tandem, and tandem), normal gait speed over 3 m, and chair rise time (5 stands) (Guralnik et al., 1994; Rantanen et al., 2018). Each test was scored from 0 (lowest) to 4 (highest). The individual test scores were summed to form a total score (range 0–12) with higher scores indicating better physical performance.

Perceived walking difficulties. Perceived walking difficulties were reported for a 2-km distance with a validated question (Mänty et al., 2007). Participants were asked whether they are able to walk 2 km, and the response options were "able without difficulty," "able with some difficulty," "able with a great deal of difficulty," "unable without the help of another person," and "unable to manage even with help." For binary logistic modeling, the responses were categorized into "no difficulties" versus "walking difficulties," when at least some difficulties in walking were reported.

Life-space mobility. Life-space mobility was assessed with the University of Alabama at Birmingham Study of Aging LSA (Baker et al., 2003), which reflects the frequency and independence of mobility through different life-space levels during the preceding 4 weeks. Life-space levels start from the person's bedroom and extend to other rooms, yard, neighborhood, town, and beyond town. Participants were asked whether they have moved in these life-space areas during the preceding 4 weeks, and if so, how often and whether they needed help from any devices or another person. A composite score (range 0–120) was used in the present analyses with higher scores indicating greater life-space mobility. The validity and reliability of the measure have been established among older people in Finland (Portegijs, Iwarsson, Rantakokko et al., 2014).

Autonomy in outdoor mobility. Autonomy in outdoor mobility was measured with the "autonomy outdoors" subscale of the validated Impact on Participation and Autonomy questionnaire (Cardol et al., 2001; Kersten et al., 2007). The outdoors subscale assesses the person's self-rated possibilities to (1) visit relatives and friends, (2) make trips and travel, (3) spend leisure time, (4) meet other people, and (5) live life as he/she wants. Responses are given on a 5-point Likert scale ranging from very good (0) to very poor (4). A sum score (range 0–20) was calculated with higher scores indicating poorer autonomy. One missing item was allowed, and total scores were imputed for two persons (one at baseline and one at follow-up) based on the mean of their existing values at the same time point.

Self-reported PA. Self-reported PA was assessed with the second part of the Yale Physical Activity Survey, which is an interview-administered questionnaire on (1) vigorous activity, (2) walking, (3) general moving, (4) standing, and (5) sitting (Dipietro et al., 1993). For the present study, we calculated a Total Activity Summary Index (range 0–137), with higher scores indicating higher PA. The validity and reliability of the scale are moderate (Schuler et al., 2001). One participant did not have data on self-reported PA at either baseline or follow-up and thus was excluded from the analysis.

Monitored PA. Participants were asked to wear a triaxial accelerometer (13-bit ± 16 g, UKK RM42, UKK Terveyspalvelut Oy, Tampere, Finland) continuously for 7–10 days pretrial (Portegijs et al., 2019) and for 6 days posttrial immediately following the home interview. Only those who participated in the pretrial monitoring (n = 139, 68% of the total sample) were invited to participate in the posttrial monitoring. The sensor was attached on the anterior aspect of the dominant thigh (i.e. the take-off leg) with a waterproof self-adhesive film. PA, expressed as mean 24-h acceleration (milligravity, mg) (Rowlands, 2018), was computed as the mean high-pass filtered vector magnitude of nonoverlapping 5-s epochs (Van Hees et al., 2013). Average acceleration summarizes all movement without an intensity threshold, combines both the intensity and duration of activity into a single measure, and produces values that are directly comparable in the same wear location. Higher values indicate a greater total volume of activity. A minimum of three full days of data were required at both assessment points.

Background characteristics. Background characteristics included categorical variables for age, gender, perceived health, marital status, living alone, and level of education. Age and gender were drawn from the national population register and other variables self-reported. Perceived health was dichotomized as good or very good health versus moderate or poorer health. The level of education was categorized as follows: high (high school diploma or university degree), intermediate (middle school, folk high school, vocational school, or secondary school), and low (primary school or less).

Statistical Methods

Participants' background characteristics were examined separately in the intervention and CGs, and between-group differences were tested with the chi-square test (χ^2). In compliance with the principles of intention-to-treat analysis

(McCoy, 2017), the intervention's effects on the different mobility and PA outcomes were tested with general estimating equation (GEE) analysis with an unstructured working correlation matrix. GEE analysis is a semiparametric method designed to work with correlated data and does not assume a normal distribution of variables (Liang & Zeger, 1986). GEE can also use information from incomplete pairs of observations and thus is suitable for use in cases of missing data in longitudinal datasets (Zhang et al., 2014). Linear models were used for continuous outcomes and binary logistic models for binary outcomes. We tested the main effects of groups and time and the interactions between these. All outcomes were analyzed in separate GEE models.

If a statistically significant group by a time effect was observed in any of the outcomes, we calculated a change score by subtracting the baseline score from the follow-up score. We used these change scores and their standard deviations to calculate effect sizes according to Cohen's d formula (Cohen, 1992). Confidence intervals (CIs) for Cohen's d were calculated using the formula by Lee (2016). In addition, we calculated relative improvement scores (percentual positive change) and tested between-group differences with the independent samples t-test and within-group differences with the paired sample t-test. All analyses were performed with IBM SPSS Statistics version 24.0 for Windows.

Results

Background Characteristics

Participants' baseline characteristics by treatment group allocation are presented in Table 1. Of the subsample of 139 volunteer participants included in the PA monitoring at baseline, 67 were randomized into the IG and 72 into the CG. The characteristics of this subsample were found to be similar in both groups (χ^2 = .58–.81, Table 1).

Intervention Effects

In the GEE analyses, group, time, and group-by-time effects were not statistically significant for life-space mobility, monitored PA (average acceleration), or perceived walking difficulties (Table 2). The time effect was significant for self-reported PA (p = .012), indicating that PA increased both in the control and IGs. The only statistically significant group-by-time effects were observed for physical performance (p = .022) and perceived autonomy (p = .011). At baseline, the IG had poorer physical performance than the CG, but during the intervention, it reached the same level of performance as the CG and thus demonstrated greater improvement (+5.0% vs +1.8%). In addition, whereas autonomy in the CG improved during the 1-year trial, autonomy in the IG declined

Table 1. Background Characteristics of the Participants by Treatment Group Allocation.

	All (n = 204)		PA Monitoring (n = 139)	
Characteristic	Intervention, N (%)	Control, N (%)	Intervention, N (%)	Control, N (%)
Age (years)				
75	75 (74)	77 (75)	49 (73)	55 (76)
80	26 (26)	26 (25)	18 (27)	17 (24)
Gender				
Female	61 (60)	63 (61)	41 (61)	46 (64)
Male	40 (40)	40 (39)	26 (39)	26 (36)
Perceived health				
Good or very good	54 (54)	64 (62)	35 (52)	41 (57)
Moderate or poorer	47 (47)	39 (38)	32 (48)	31 (43)
Marital status				
Married	61 (60)	68 (67)	46 (69)	51 (72)
Not married	40 (40)	34 (33)	21 (31)	20 (28)
Living alone				
Yes	37 (37)	33 (32)	20 (30)	20 (28)
No	64 (63)	70 (68)	47 (70)	52 (72)
Level of education				
High	28 (28)	32 (31)	18 (27)	21 (29)
Intermediate	48 (48)	56 (54)	35 (52)	39 (54)
Low	24 (24)	15 (15)	14 (21)	12 (17)

Note. PA = physical activity.

Table 2. Means of Mobility and Physical Activity Variables by Treatment Group Allocation at Baseline and at 12-Month Follow-Up, and *p*-Values for Group, Time, and Group-By-Time Interaction Effects Tested with General Estimating Equation Analysis.

	Baseline	Follow-Up	Group	Time	Group × Time
Outcome	Mean (*SD*)	Mean (*SD*)	*p*-Value	*p*-Value	*p*-Value
Physical performance			.010	.060	.022
Intervention	10.6 (1.6)	11.2 (1.3)			
Control	11.0 (1.2)	11.2 (1.1)			
Life-space mobility			.482	.807	.409
Intervention	74.4 (9.2)	76.3 (14.5)			
Control	74.7 (9.3)	74.9 (13.6)			
Autonomy in mobility			.043	.204	.011
Intervention	4.2 (3.1)	4.8 (3.3)			
Control	4.7 (3.5)	4.3 (2.5)			
Self-reported PA[a]			.512	.012	.462
Intervention	58.9 (24.0)	65.6 (24.3)			
Control	60.3 (20.5)	65.1 (22.6)			
Average acceleration (mg)[b]			.401	.782	.603
Intervention	23.9 (5.9)	24.0 (7.4)			
Control	25.6 (8.4)	25.3 (9.9)			
2 km walking difficulty, no			.841	.994	.738
Intervention	81%	78%			
Control	84%	84%			

Note. All outcomes were analyzed in separate models. PA = physical activity, mg = milligravity, *SD* = standard deviation. *N* = 204 for other models.
[a]*n* = 203.
[b]*n* = 139.

(+1.7% vs −3.0%, Figure 1). The effect size for physical performance was $d = .31$ (95% CI .02–.59) and for perceived autonomy $d = .36$ (95% CI .07 –.64).

Discussion

The individualized active aging counseling intervention had no systematic effects on mobility or PA among older people. Instead, the effects were inconsistent depending on the aspect of mobility studied, as physical performance improved and sense of autonomy declined in the IG. Self-reported PA increased in both groups. No treatment effects were observed for life-space mobility, perceived difficulties in walking 2 km, or monitored PA. Although the potential association of striving for participation in meaningful activity with greater life-space mobility and PA has been established in previous observational studies (Saajanaho et al. 2015), increased active aging (Rantanen et al., 2020) did not translate to enhanced life-space mobility in the present randomized controlled trial.

Compared with controls, a small but statistically significant improvement was observed in physical performance in the IG but no change in perceived difficulty in walking 2 km. Compared with the binary perceived walking difficulty variable, the SPPB score is more sensitive to change (Ostir et al., 2002) and captures smaller improvements. Our anecdotal data from the counseling sessions suggest that some

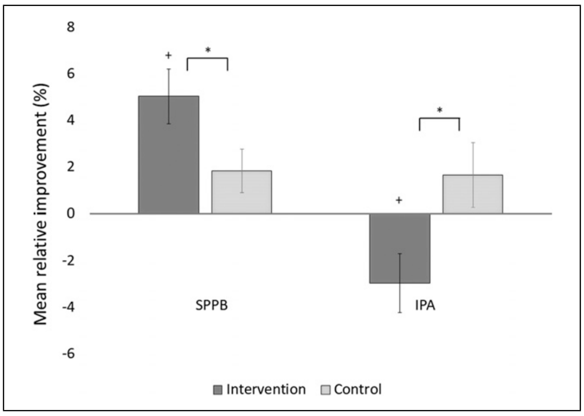


Figure 1. Mean relative improvements (%) with standard errors in physical performance (Short Physical Performance Battery) and perceived autonomy in outdoor mobility (Impact on Participation and Autonomy outdoors subscale) during the 12-month trial by treatment group allocation. * Significant between-group difference, + significant within-group difference, $p < .05$.

participants in the IG started resistance training or at-home exercises. These physical activities may not be fully captured by accelerometers or PA and life-space mobility questionnaires but will likely improve lower extremity performance (Rantanen, 2013).

Autonomy in outdoor mobility declined in the IG but was slightly enhanced in the CG. This was counter to our expectations because the counseling approach was autonomy-supporting and we used behavioral change techniques, such as problem solving and action planning, which aimed at helping participants obtain social and practical support in performing their selected activities. No established cut point exists for a meaningful change in the present autonomy score; however, the small decline observed may have been meaningful as it reflects participants' own perceptions of their everyday life. The decline may potentially be explained by participants becoming aware of available activities during the intervention but not receiving practical help in engaging in them (Brandtstädter, 2009). Thus, we may have unintentionally created an imbalance in people's aspirations for activity relative to their resources.

Although no treatment effects were found on life-space mobility or objectively monitored PA, self-reported PA increased in both groups. Compared with those participating in the self-reports only, those also involved in the PA monitoring reported fewer depressive symptoms and a higher level of PA (Rantanen et al., 2019), thus potentially possessing less room for improvement in their activity levels. However, self-reported PA increased similarly among both subgroups, making selection bias an unlikely explanation for this finding. Instead, it has been found that self-reports of PA are vulnerable to bias related to social desirability and approval (Adams et al., 2005) and may lead to overestimations of activity (Steene-Johannessen et al., 2016). The similar change in the intervention and CGs may be due to the Hawthorne effect, that is the fact that people often act differently simply because they are being studied rather than because of the intervention they are receiving (Becker et al., 2003).

Overall, these findings imply that changing everyday behaviors is challenging. According to anecdotal data from the counseling sessions, many of our participants preferred striving to maintain their current situation and activity rather than setting new activity goals. This maintenance rather than growth orientation in goal pursuit is common in old age and correlates with well-being (Ebner et al., 2006) but may have led to invariability in the present outcomes. In addition, although the counseling was centered on promoting out-of-home activity, some people rather set goals related to more sedentary and at-home activities. Furthermore, as we detected only small increases in the trial's primary outcome variable of overall activity (Rantanen et al., 2020), it is understandable that the changes in mobility and PA outcomes were also modest. Finally, recruitment for the present trial was based on a population-based probability sample, which should reduce selection bias. However, activity studies of this kind tend to attract healthy, active, and interested people (Portegijs et al., 2019), which, in turn, may lead to participants with higher than expected levels of functioning and activity.

Strengths of the Study

The strengths of this study include the randomized controlled trial design and the use of validated and established measures. Unlike in many earlier studies, we considered various mobility and PA outcomes, including both subjective and objective measures. In addition, our population-based sample contained both men and women at ages that are vulnerable to functional decline. Finally, we had barely any missing data and low attrition, as only a few participants dropped out of the rather long trial. Furthermore, we applied GEE analysis, which also takes unpaired observations into account (Zhang et al., 2014) in examining the causal associations.

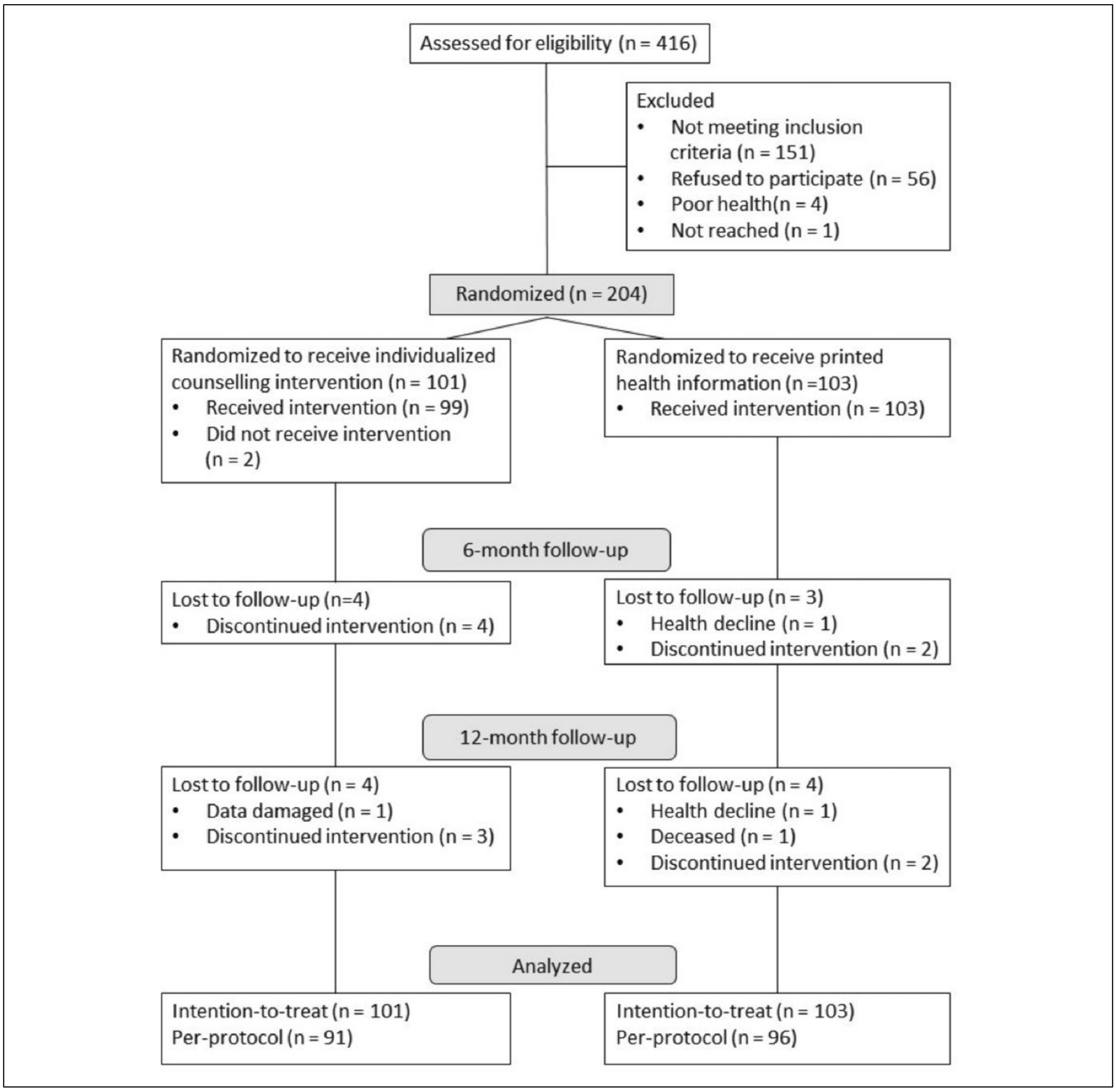
Study Limitations

A notable limitation in this study was the use of only two assessment points: baseline and 12 months thereafter. Thus, we do not know how mobility or PA might have changed in between these time points. For example it is possible that the intervention positively affected mobility and/or PA immediately after the face-to-face counseling, but as face-to-face contact was replaced by phone calls and became less frequent, such effects diminished. In addition, we may have failed to recruit enough people with early phase decline in health and activity, as such individuals would likely have had more room and motivation for increasing their level of activity. Finally, it should be noted that PA patterns and life-space mobility may be highly variable due to the normal variation in everyday life (Terwee et al., 2010) or other factors such as weather conditions (Portegijs, Iwarsson, Rantakokko et al., 2014) that make it harder to detect change in longitudinal data with momentary assessments of mobility.

Conclusion

We found that individualized counseling centered on increasing self-selected meaningful activity outside the home has inconsistent effects on mobility and PA. Although modest positive changes were seen in physical performance in the IG, perceived autonomy in outdoor mobility declined and no divergent changes were observed in the other outcome variables. This suggests that promoting mobility and PA is no easy task in population-based studies targeting increased participation in a variety of activities. Because earlier studies on individualized PA counseling have reported more positive results for physical function (Mänty et al., 2009) and PA (Rasinaho et al., 2012), we may deduce that future interventions tailored specifically for increasing participation in mobility-related and physical activities could yield greater positive effects than those reported here.

Appendix A. Flowchart of the Study (Originally Published in Rantanen et al. (2020)).



Acknowledgements

The authors wish to acknowledge CSC—IT Center for Science, Finland, for computational resources. The Gerontology Research Center is a joint effort between the University of Jyväskylä and the University of Tampere.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was financially supported by the European Research Council (grant number 693045 to TaRa), the Academy of Finland (grant number 310526 to TaRa, 321336, and 328818 to TiRa), and the Finnish Ministry of Education and Culture (to EP). The preparation of this article (MS) was also funded by the Academy of Finland (grant number 323541). The funders had no role in designing and implementing the study or reporting the analyses. In addition, the content of this article does not reflect the official opinion of the European Union. Responsibility for the information and views expressed in the article lies entirely with the authors.

Ethical Statement

All participants gave their verbal and written informed consent before data collection, and the trial followed the principles of the Declaration of Helsinki. Ethical statement for the study was provided by the Central Finland Hospital District on August 23, 2017.

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