

EUR Research Information Portal

Functional limitations and mental well-being among frail older adults

Published in:

Aging and Mental Health

Publication status and date:

E-pub ahead of print: 03/04/2025

DOI (link to publisher):

[10.1080/13607863.2025.2484639](https://doi.org/10.1080/13607863.2025.2484639)

Document Version

Publisher's PDF, also known as Version of record

Document License/Available under:

CC BY

Citation for the published version (APA):

Islam, M. K., Lamu, A. N., Ruths, S., Mølken, M. R. V., & Askildsen, J. E. (2025). Functional limitations and mental well-being among frail older adults: the mediating effect of social relationships. *Aging and Mental Health*. Advance online publication. <https://doi.org/10.1080/13607863.2025.2484639>

[Link to publication on the EUR Research Information Portal](#)

Terms and Conditions of Use

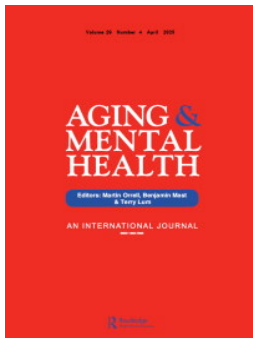
Except as permitted by the applicable copyright law, you may not reproduce or make this material available to any third party without the prior written permission from the copyright holder(s). Copyright law allows the following uses of this material without prior permission:

- you may download, save and print a copy of this material for your personal use only;
- you may share the EUR portal link to this material.

In case the material is published with an open access license (e.g. a Creative Commons (CC) license), other uses may be allowed. Please check the terms and conditions of the specific license.

Take-down policy

If you believe that this material infringes your copyright and/or any other intellectual property rights, you may request its removal by contacting us at the following email address: openaccess.library@eur.nl. Please provide us with all the relevant information, including the reasons why you believe any of your rights have been infringed. In case of a legitimate complaint, we will make the material inaccessible and/or remove it from the website.



Functional limitations and mental well-being among frail older adults: the mediating effect of social relationships

M. Kamrul Islam, Admassu N. Lamu, Sabine Ruths, Maureen Rutten-van Mölken & Jan Erik Askildsen

To cite this article: M. Kamrul Islam, Admassu N. Lamu, Sabine Ruths, Maureen Rutten-van Mölken & Jan Erik Askildsen (03 Apr 2025): Functional limitations and mental well-being among frail older adults: the mediating effect of social relationships, *Aging & Mental Health*, DOI: [10.1080/13607863.2025.2484639](https://doi.org/10.1080/13607863.2025.2484639)

To link to this article: <https://doi.org/10.1080/13607863.2025.2484639>



© 2025 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group



Published online: 03 Apr 2025.



Submit your article to this journal [↗](#)



Article views: 326



View related articles [↗](#)



View Crossmark data [↗](#)

Functional limitations and mental well-being among frail older adults: the mediating effect of social relationships

M. Kamrul Islam^{a,b}, Admassu N. Lamu^b, Sabine Ruths^{b,c}, Maureen Rutten-van Mölken^d and Jan Erik Askildsen^a

^aDepartment of Economics, University of Bergen, Bergen, Norway; ^bHealth and Social Sciences, NORCE Norwegian Research Centre, Bergen, Norway; ^cDepartment of Global Public Health and Primary Care, University of Bergen, Bergen, Norway; ^dSchool of Health Policy and Management, Erasmus University Rotterdam, Rotterdam, the Netherlands

ABSTRACT

Objectives: Physical functional limitations come with aging that impact social relationships and participation (SRP). This study aimed to investigate whether SRP mediates the association between functional limitations and MWB in frail older adults.

Method: We used survey data collected from 338 frail older adults in Norway between 2017 and 2019. Older adult's functional limitation was measured by activities of daily living (ADL). Linear regressions were used to estimate the effect of ADL and SRP on MWB, and the effect of ADL on SRP. A structural equation model (SEM) was used to decompose the total effect of ADL on MWB into direct and indirect (via SRP) effects.

Results: We found that both ADL and SRP significantly predicted MWB. The effect of ADL on SRP was also statistically significant ($\beta = 0.265$; $p < 0.01$). The direct effect of ADL was higher ($\beta = 0.763$; $p < 0.01$) than its indirect effect ($\beta = 0.383$; $p < 0.01$). The proportion of the total effect that is mediated was about 34%. Analyses from the longitudinal framework showed similar results.

Conclusion: Healthy aging can improve MWB directly or indirectly through better SRP. Our findings may have important implications for the design of health policies for older adults by further focusing on maintaining and investing in SRP.

ARTICLE HISTORY

Received 2 December 2024

Accepted 21 March 2025

KEYWORDS

Older adults; functional limitations; mental well-being; social relationships; structural equation modelling

Introduction

The proportion of older adults is increasing globally, particularly in high-income countries. The latest national population projections in Norway indicate that the share of the population aged 65 years and above will increase from 18% in 2020 to 30% in 2070 (Syse et al., 2020). With aging, the prevalence of chronic diseases and disabilities is increasing globally. National surveys in different countries show that mental disorders are common and constitute a major source of disability (Jorm et al., 2017). In 2019, one in every eight (or 970 million) people around the world lived with a mental disorder, with anxiety and depressive disorders being the most common (Institute for Health Metrics and Evaluation, 2019). According to the World Health Organization (WHO), depression stands out as the leading contributor to global disability, accounting for 7.5% of all years lived with disability, while anxiety disorders rank sixth, contributing 3.4% of the global burden (GBD Mental Disorders Collaborators, 2022; WHO, 2017).

Older adults not only face difficulties in life common to the general population but also encounter challenges that are more common in later life, such as a continuous loss of capacities and a decline in functional ability (WHO, 2019). In addition, older adults are more likely to encounter adverse events such as bereavement, or a drop in income upon retirement (WHO, 2023). These difficulties can increase the need for long-term care (WHO, 2019). The aging of the population has also

important budgetary implications. The Organization for Economic Co-operation and Development (OECD) projections predict that budgetary pressures in the coming decades are likely to come mainly from rising long-term care spending (OECD/European Observatory on Health Systems Policies, 2019). Thus, measures aimed at promoting healthy aging stand out as important policy challenges facing individuals and societies.

Improvement in social relationship and participation (SRP), relating to friends, family, and the community at large, may improve quality of life, happiness, and enhance older adults' psychological well-being (Conner et al., 1979; Fowler & Christakis, 2008; Huxhold et al., 2014). SRP are recognized as key components in many conceptual models of successful aging, and remain a focus of ongoing research (Levasseur et al., 2010). As to the relationship between physical functional limitations (hereafter functional limitations) and SRP, evidence from a longitudinal study (Sirven & Debrand, 2012) showed that the average causal effect of physical health on social relationships was significantly greater than the reverse effect (i.e. from SRP to functional limitations). As people age, functional limitations often arise, preventing them from independently taking care of their basic needs, which negatively impacts their social life and mental health (Rosso et al., 2013). Although the relevance of SRP for general well-being is increasing globally (Serrat et al., 2020), there is still limited evidence on whether SRP mediates the known association between functional limitations and mental wellbeing (MWB). Understanding the interrelations between

functional limitations, SRP and MWB would have important implications for the design of health and social policies for frail older populations.

Many studies have investigated the partial effects of functional limitations on social participation (Costenoble et al., 2022; De Belvis et al., 2008; Imamura et al., 2016; Tomioka et al., 2017), and of social support on mental health (Fastame et al., 2018; Feng et al., 2014; Huang, 2019; Kawachi & Berkman, 2001). However, studies that have distinguished between the direct and indirect effects of functional limitations on MWB are scarce. For instance, a study on the relationships between functional limitations and psychosocial distress in a Norwegian population suggested that social support mediated this link (Backe et al., 2018). A similar study based on older adults in rural China found a mediating effect of social support in the association between functional disability and psychosocial distress only in people aged 75+ years (Feng et al., 2014). A Norwegian study based on a random sample of individuals aged 65+ years living at home showed that the adverse effect of somatic health problems on psychosocial distress was mediated by weakened social support (Bøen et al., 2012). A recent study of the German working population aged 40 to 54, indicated that social support mediated the effect of multimorbidity on MWB (Demirer et al., 2021). Kong and colleagues found that social support could be an important mediator of the association between depression and quality of life among community-dwelling older adults with chronic disease (Kong et al., 2019). All these studies differ in their definitions of exposure (functional limitations), mediator (social support), and outcome (psychosocial wellbeing) measures. Functional limitations are restrictions that prevent frail older adults to perform their activities of daily living (ADL) optimally. Thus, ADL is used as an indicator of an individual's functional status.

Conceptual framework and model specification

We hypothesized that greater functional limitations (measured by ADL) were associated with more restricted SRP and poorer MWB. Thus, we explored the association of ADL with MWB, and the role SRP plays in this link, that is, we sought to evaluate the simple conceptual model depicted in Figure 1.

The rationale for this conceptual model is that by choosing a sample of frail older adults with multimorbidity, it is more plausible to assume that their functional limitations affect their capabilities to maintain good social relationships, than the reverse scenario. Previous longitudinal studies on the bidirectional relationship between social isolation and frailty also indicated that frailty indicators are more predictive of social isolation (Maltby et al., 2020; Mehrabi et al., 2024; Pan & Yu, 2024). There is much evidence that individuals with chronic conditions or

disabilities experience restrictions in social relationships and role fulfillment. The question is to what extent SRP mediates the association between ADL and MWB. Therefore, the objective was to disentangle the indirect effect of ADL on MWB *via* SRP, from its direct effect.

Methods

Participants and data

The study population comprised a sample of frail older adults with multimorbidity. Frail older adults were defined as individuals who begin their use of municipal home care services or who are on a short-term stay in a nursing home due to functional deterioration. The data were collected as part of the SELFIE (Sustainable integrated chronic care modelS for multi-morbidity: delivery, Financing, and performance) project (Islam et al., 2021). Of the sixteen participating municipalities in Norway, twelve took part in the 'Holistic Continuity of Patient Care' (HCPC) program aimed at frail older adults. It entails the assignment of a designated primary care contact, prompt engagement with the patient's general practitioner, early assessment, and patient-centered follow-up. The remaining four municipalities did not participate in the HCPC program during our study period (non-HCPC) and received usual care.

Primary contact persons (HCPC-municipalities) and research assistants (non-HCPC municipalities) recruited participants, provided study information, collected informed consent, and completed the SELFIE-questionnaire for frail older adults based on a face-to-face patient interview in the patient's home or nursing home. Data collection was conducted from September 2017 to June 2019. The study utilized data from 338 individuals with 206 participants from HCPC- and 132 from non-HCPC municipalities at two time points. Detailed descriptions of the participants and data were reported elsewhere (Islam et al., 2021).

The inclusion criteria for both HCPC and non-HCPC municipalities were (i) frail older adults; (ii) use of municipal home care services; (iii) a short-term stay in a nursing home due to functional deterioration. Furthermore, the HCPC group comprised exclusively home-dwelling frail elderly people, while the non-HCPC group was mainly recruited from short-term nursing home rehabilitation stays. Within the eligible study population, there were no exclusion criteria. For patients with cognitive functional abilities, next of kin was invited to fill out the questionnaires. In HCPC municipalities, a designated coordinator is assigned, and a GP visit is planned. In contrast, no designated coordinator is assigned in non-HCPC municipalities.

After scrutinizing the data, we found a few missing values only for the SRP variable (3%). When missing data is small (<5%), the potential impact of missingness is likely trivial (Dettori et al., 2018). However, to preserve the full sample, we applied the Full Information Maximum Likelihood (FIML) method, which utilizes observed information from all variables in the models. This gives unbiased parameter estimates with missing data at random.

Variables

Outcome variable – mental wellbeing (MWB)

We measured MWB using the validated five-item version of Mental Health Inventory (MHI-5) questionnaire (Berwick et al., 1991). These items pertain to mood during the past month, with two items assessing the presence of psychological well-being (Were you a happy person? Have you felt calm and peaceful?),

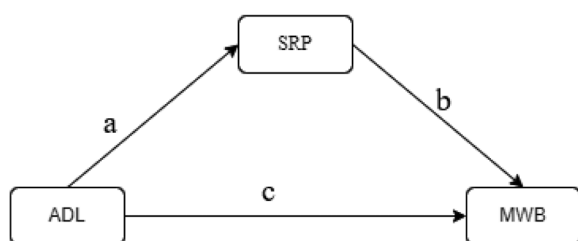


Figure 1. Conceptual model with exposure ADL, mediator SRP, and MWB as outcome.

Note: ADL: Activities of daily living; SRP: social relationships and participations; MWB: mental wellbeing.

and three items (inverse-coded) concerning the absence of psychological distress (Have you been a nervous person? Have you felt downhearted and blue? Have you felt so down in the dumps that nothing could cheer you up?). Each item has six severity levels ranging from 1 (None of the time) to 6 (All of the time). The total score of the MWB was linearly transformed onto a 0–100 scale following the scoring guideline (Ware, 2002). Higher scores indicate better MWB. Cronbach's alpha (α) for the MWB is 0.83, indicating its good internal consistency, which is similar to previous evidence from the Norwegian population (Strand et al., 2003). Furthermore, a study based on the Finnish general population indicated that the MHI-5 has good psychometric properties, with good reliability ($\alpha=0.89$) and a unidimensional factorial structure (Elovainio et al., 2020). An operational advantage of the MHI-5 as a measure of MWB is twofold: it is shorter, and thus easy to administer; and it is widely used, not only in psychiatric surveys but also in general health surveys.

There is no consensus in the literature about which clinical cut-off point is optimal for predicting mental health disorders assessed by the MHI-5. A recent study based on the general population suggested the optimal cut-off point of 76 or less for any mood and/or anxiety disorder on the MHI-5 scale (Ten Have et al., 2024). Similar cut-off points were proposed to define a case for a common mental disorder using the MHI-5 (Kelly et al., 2008).

Mediator – social relationship and participation (SRP)

SRP was measured using the social life & relationships domain of a validated handicap questionnaire developed by Cardol et al. (1999)—the 'Impact on Participation and Autonomy (IPA)'. It measures not only the extent of participation but also the quality of participation experienced using seven self-reported questions: (1) Conversation on equal terms with those nearest and dearest; (2) Quality of relationship with those nearest and dearest; (3) Receiving respect from those nearest and dearest; (4) Quality of relationship with acquaintances; (5) Receiving respect from acquaintances; (6) The chances of having an intimate relationship; and (7) The frequency of contacts. Each question has five response options ranging from 0 to 4, where 0 = Very poor, 1 = poor, 2 = Fair, 3 = Good, 4 = Very good. The SRP domain ranges from 0 to 28, where higher scores indicate better relationships. It has a good scale reliability ($\alpha=0.80$). A study based on a Dutch adult population with multimorbidity also indicated a good psychometric property ($\alpha=0.86$) for the SRP domain (Cardol et al., 2001).

Independent (exposure) variable – activities of daily living (ADL)

ADL as an indicator of physical functioning was measured by self-reported Katz-15 that includes six basic-ADL items (Katz et al., 1963; Laan et al., 2014), seven items from the Lawton instrumental-ADL (Lawton & Brody, 1969) plus two extra items. For the ADL index, respondents were asked whether they currently needed assistance to perform 15 different activities (Spector & Fleishman, 1998): bathing, dressing, toileting, use of incontinence products, sitting down and getting up from a chair (transferring), eating, use of telephone, shopping, preparing meal, taking care of house, travelling, taking medications, financial management, grooming, and walking. Each item (reverse-coded) has two response levels: 0 = Yes, I need help, and 1 = Independent (not need help to do these activities). The ADL

index ranges from 0 (most difficulties and worst physical health) to 15 (full functioning and best physical health). The ADL also demonstrates good internal reliability ($\alpha=0.83$). A randomized controlled study from a Dutch community-dwelling frail older people also found good internal consistency of ADL ($\alpha=0.82$) (Laan et al., 2014).

Control variables

Control variables include age, gender, multimorbidity (no/single chronic condition vs multiple chronic conditions), marital status (single, married, divorced, or widowed), living situations (living alone vs living with someone), education (primary including lower-secondary, high school, tertiary). The experience of care (EoC) one may receive in the face of an emotional or physical crisis can also influence wellbeing, and was therefore included. It emphasizes person-centered care, ensuring that the care provided aligns with an individual's needs, capabilities, and preferences, while fostering joint decision-making. The Person-Centered Coordinated Care Experiences Questionnaire (P3CEQ) is used to assess EoC (Sugavanam et al., 2018). EoC is measured by six questions related to experience and understanding of care received from health and social care providers in the last month (Lloyd et al., 2019). The first five questions address aspects such as what is important for managing health and well-being; involvement in care decisions; being considered as a whole person; involving family/friends/carers in decisions; and enough support from care team to manage health and wellbeing, each with four response options (0 = Not at all to 3 = Always). The sixth question asks about receiving useful information when needed, with five response options ranging from 0 (Do not receive any information) to 4 (Receive too much information). We used its summary score that ranges from 0 to 19. Since data were collected from municipalities with and without HCPC programs across two-time points, we also controlled for municipalities (HCPC vs non-HCPC) and assessment period (baseline vs follow-up). See Table 1 for variable descriptions.

Statistical analysis

We used descriptives to analyze the baseline characteristics of the study sample. We pooled data from HCPC and non-HCPC for the two time points, because this allows for a larger sample size ($N=338$), which enhances the ability to detect significant effects and generalize results across different groups or contexts. It also improves statistical power and precision of the estimated parameter. First, linear regressions were used to estimate: (i) the effect of ADL and SRP on MWB; and (ii) the effect of ADL on SRP. All models were adjusted for control variables. Second, a Structural Equation Model (SEM) was used to estimate and decompose the total effect of ADL on MWB into direct and indirect (*via* SRP) effects. That is, we estimated the conceptual model depicted in Figure 1 by using SEM. We opted for SEM due to its capacity to model complex relationships and provide more precise, comprehensive insights compared to traditional methods. SEM uses the system of regression equations and path diagrams to test such complicated mediation models in a single analysis (Gunzler et al., 2013).

Assuming X is the exposure or independent variable (measured by ADL), M is a mediator (measured by SRP), and Y is the outcome (measured by MWB), the standard mediation approach involves three equations:

Table 1. Description of variables.

Variables	Mean/Count (<i>n</i> = 338)	SD/Share (%)
Mean and standard deviation (SD)		
Mental wellbeing	74.75	18.98
Activities of daily living	9.63	3.41
Social relationships	16.22	4.49
Experience of care	11.16	4.17
Count and proportion, <i>N</i> /%		
Age (in years)		
45–79 years	112	0.33
80–85 years	80	0.24
85+ years	146	0.43
Gender		
Women	186	0.55
Men	152	0.45
Marital status		
Single	22	0.07
Married	137	0.41
Widowed	136	0.40
Divorced	43	0.13
Education		
Primary	122	0.36
High school	127	0.38
Tertiary	89	0.26
Multimorbidity		
No/single chronic condition	22	0.07
Multiple chronic conditions	316	0.93
Living situation		
Live with someone	143	0.42
Alone	195	0.58
Municipality		
Non-HCPC municipality	132	0.39
HCPC municipality	206	0.61
Assessment period		
Baseline	207	0.61
Follow-up	131	0.39

Note: We reported count (*N*) and percentage share (%) for categorical variables, and mean and standard deviation (SD) for continuous variables.

$$E(Y | X) = I_1 + tX_i + e_{i1} \quad (1)$$

$$E(M | X) = I_2 + aX_i + e_{i2} \quad (2)$$

$$E(Y | X, M) = I_3 + bM_i + c'X_i + e_{i3} \quad (3)$$

Where *I* stand for constant intercepts and *e* for error terms that are assumed to be independent across equations. Equation (1) gives the total effect of ADL on MWB (the regression coefficient *t*). Equation (2) gives the effect of ADL on the mediator variable SRP (*a* path). Equation (3) gives the effect of the exposure *X* on the outcome *Y* controlling for the mediator variable *M* (the *c'* path indicating the direct effect of *X* on *Y*). In SEM, the point estimate of the indirect effect is computed as the product of coefficients *a* and *b* (*a***b*).

To ensure the robustness and consistency of our results from the pooled data analysis, we also employed a longitudinal framework to decompose the total effect of ADL on MWB into direct and indirect (*via* SRP) effects. In this model, the outcome variable (MWb) was measured at the follow-up period, and the predictor variables were derived from baseline data. Since some participants dropped out during the follow-up period (i.e. sample attrition), we imputed them using the FIML method that was built in SEM.

In addition to chi-square statistics, we used alternative fit indices to examine model fit to the data for the SEM. These fit indices included the comparative fit index (CFI), the Tucker–Lewis index (TLI), and the root mean square error of approximation (RMSEA). Hu and Bentler (1999) suggested that RMSEA

smaller than 0.06, a CFI and TLI larger than 0.95 are considered excellent model fits. We conducted all statistical analyses using Stata® ver. 18.0 (StataCorp LP, College Station, Texas, USA).

Results

Descriptives

Table 1 shows that around 26% of the respondents had tertiary education. Mean (SD) age of the sample was 81.5 (9.3) years, 55% were women, and 40% had lost their spouse. The vast majority (93%) reported multiple chronic conditions. On average, each participant had experienced more than 5 functional limitations (mean ADL = 9.63, SD = 3.41). Mean (SD) SRP and MWb was 16.22 (4.51) and 74.75 (18.98), respectively. The pair-wise correlation coefficients among key variables were all significant (*p* < 0.01). We observed the highest correlation coefficient (>0.42) between the SRP and the MWb variables.

Test of model fit in SEM

SEM fits a system of regressions simultaneously, and the fit indices suggest that our model fits the data very well. The small chi-square value was insignificant ($\chi^2 = 1.116$, *p* = 0.291), indicating a good model fit. The CFI of 0.999, TLI = 0.978, and RMSEA value of 0.019 indicate an excellent model fit.

Linear regression results: associations between exposure, mediator, and outcome

Table 2 presents the detailed linear regression results, with Panel-A showing the effect of ADL (exposure) and SRP (mediator) on MWb (outcome), and Panel-B reporting the effect of ADL on SRP. The association of ADL and MWb was positive and significant. The ADL had a positive significant effect on SRP as expected. Both the exposure (ADL) and mediator (SRP) showed positive significant effects on the outcome (MWb). Except for age and experience of care, no other control variables were significantly associated with MWb. Whereas being married, education and type of municipality were significantly associated with the mediator, SRP.

Effect decomposition results from SEM

Table 3 reports the mediation results—direct and indirect (*via* SRP) effects—of ADL on MWb. Panel-A shows results from the pooled data. The total effect of functional limitation (measured by ADL) on MWb was positive and significant ($\beta = 1.146$, *p* < 0.01). An improvement in one functional limitation was associated with a 1.146 increase in MWb. We observed the strongest evidence of the direct effect of ADL on MWb ($\beta = 0.763$, *p* < 0.01). The proportion of the total effect mediated (i.e. the overall proportion attributed to the mediating effect of SRP) was close to one-third, implying that ADL retained a stronger direct effect on MWb after accounting for all covariates (including demographic variables, comorbidities, as well as municipalities and time fixed effects). The ratio of the indirect effect to the direct effect was about half of the size of the direct effect. The total effect was nearly 1.50 times the direct effect. Panel-B reports results from longitudinal data. The findings are similar to the results from the pooled data analysis.

Table 2. Linear regression results for the outcome (MWB) and mediator (SRP) variables.

Variables	Coefficient (SE)	95% CI		Coefficient (SE)	95% CI	
		Lower	Upper		Lower	Upper
Panel-A. Dependent Variable: MWB				Panel-B. Dependent Variable: SRP		
ADL	0.763 (0.291)	0.193	1.332	0.265 (0.067)	0.133	0.398
SRP	1.443 (0.234)	0.986	1.901	–	–	–
Age						
80–85 years	2.999 (2.609)	–2.114	8.112	0.228 (0.622)	–0.991	1.447
85+ years	6.777 (2.424)	2.027	11.528	0.819 (0.584)	–0.326	1.965
Gender						
Male	1.839 (1.94)	–1.964	5.643	0.719 (0.461)	–1.623	0.185
Marital						
Married	1.784 (4.792)	–7.609	11.176	2.482 (0.937)	0.646	4.318
Widowed	2.355 (4.012)	–5.508	10.219	0.697 (0.954)	–1.172	2.567
Divorced	–1.581 (4.402)	–10.209	7.047	0.64 (1.049)	–1.416	2.696
Education						
High school	–1.216 (2.137)	–5.404	2.973	1.243 (0.508)	0.248	2.238
Tertiary	–1.356 (2.412)	–6.084	3.371	1.224 (0.576)	0.095	2.353
Experience of care	0.578 (0.234)	0.119	1.037	0.328 (0.053)	0.225	0.432
Multimorbidity						
Multiple chronic conditions	–0.634 (3.722)	–7.929	6.660	–0.237 (0.912)	–2.025	1.551
Living situation						
Alone	–2.808 (3.215)	–9.108	3.492	–	–	–
Municipality						
HCPC municipality	1.035 (1.998)	–2.881	4.951	–1.683 (0.466)	–2.596	–0.770
Assessment period						
Follow-up	3.094 (1.873)	–0.576	6.765	–0.874 (0.447)	–1.749	0.001
Constant	32.803 (7.484)	18.135	47.472	9.356 (1.6)	6.220	12.491

Note: ADL = Activities of daily living; SRP = Social relationship and participation; MWB = Mental wellbeing; SE = (Robust) standard errors in parentheses.

Table 3. SEM mediation results: direct and indirect (*via* SRP) effects of ADL on MWB.

	Coefficient	SE	p-Values
Panel-A: Pooled data			
Direct effect			
ADL → SRP	0.265	0.067	0.000
ADL → MWB	0.763	0.291	0.009
SRP → MWB	1.443	0.234	0.000
Indirect effect			
ADL → SRP → MWB	0.383	0.116	0.001
Total effect	1.146	0.299	0.000
Panel-B: Longitudinal data			
Direct effect			
ADL → SRP	0.280	0.091	0.002
ADL → MWB	0.847	0.384	0.027
SRP → MWB	1.491	0.292	0.000
Indirect effect			
ADL → SRP → MWB	0.413	0.157	0.009
Total effect	1.260	0.397	0.002

Note: ADL = Activities of daily living; SRP = Social relationship and participation; MWB = Mental wellbeing; SE = Standard error.

Discussion

In this study, we examined the direct and indirect effects of physical functioning status on MWB among frail older adults with multimorbidity. We used SEM to evaluate whether the effects of ADL on MWB are mediated by social relationships. This is important for both researchers and policymakers in understanding the pathways through which physical functioning status of frail older adults may influence MWB. Two key findings emerged: functional limitations significantly affect SRP, and it also has both indirect (*via* SRP) and direct effects on MWB.

Our study extends previous research by empirically identifying the instrumental value of functional limitations on MWB (i.e. its indirect effect *via* SRP) as distinct from its intrinsic value, which bears a direct effect on MWB. It is plausible that physical health limitations can coerce older adults to gradually withdraw from their social networks, deterring their social interaction and participation with friends. Furthermore, older adults with physical limitations may feel anxious due to their perceived inability

to fulfill responsibilities in social relationships, ultimately leading them to lose social connections (Aartsen et al., 2004). Thus, the presence and intensity of functional limitations affect MWB, and some of this effect is due to a lack of high-quality social relationships.

Previous studies provide evidence that poor social relationships adversely impact MWB (Boen et al., 2012; Conner et al., 1979; Dawson-Townsend, 2019; Forsman et al., 2013; Kawachi & Berkman, 2001) and that functional limitations also exert a strong effect either directly or indirectly by creating additional stressors (Brown, 2017; Miao & Bierman, 2023). For instance, aspects of negative social interactions, such as discounting, negative partner response to pain, and lack of understanding, were found to be negatively associated with mental health (Kool et al., 2013; Tough et al., 2017). A review of the literature found consistent associations between social support and composite mental health scores (Tough et al., 2017). Thus, the decisive factor in the association between functional limitations and MWB may be social support, where functional limitations will lead to loneliness and social isolation, which in turn leads to psychological distress (Backe et al., 2018). The novel finding of the present study is that functional limitations reduce SRP, thereby triggering mental health in frail older adults with multimorbidity, that is, beyond its direct effect, the indirect effect of functional limitations through SRP is substantial. Our findings corroborate with other studies among older adults, indicating that social support significantly mediates the association between functional limitations and psychosocial distress (Backe et al., 2018; Boen et al., 2012; Feng et al., 2014; Yang, 2006). Perceived social support can also increase feelings of self-esteem and self-worth, which in turn can improve MWB. Results from these previous studies were reported using anxiety, depression, or the combination of both as the outcome variable and social support as the mediator, in contrast to a composite measure of MWB and SRP applied in the present study.

Our findings suggest that interventions that can prevent or limit loss in physical functioning would be effective in

improving both older adults' social participation and their MWB. Moreover, integrating frail older adults into social networks and strengthening the quality of their social relationships and participations could provide favorable benefits to MWB of older adults. As such, policies that promote appropriate social activities and ensure the implementation of these activities among older adults are warranted. Financial support that improves the physical environment of older people and strengthens their social participation is also important, i.e. improving infrastructures that enable older people's participation in community activities (Portegijs et al., 2022). Promoting cultural and social events at the community and family level targeting the older adults could flourish the social and mental wellbeing of the older people.

This study has several strengths. First, the use of a multi-item questionnaire offers better psychometric properties than a single-item measure of MWB. We utilized the MHI-5, which consists of five questions focusing on individuals' feelings and experiences related to mental health. Moreover, the MHI-5 demonstrates a predictive ability similar to the more comprehensive 12-item General Health Questionnaire (GHQ-12) (Hoeymans et al., 2004). However, the MHI-5 has operational advantages compared to GHQ-12, because it is short and can be used in both mental health and general health, as well as quality of life surveys. Second, we used a unique composite measure of SRP, which combines the quality and frequency of social relationships with primary ties (close friends and families) and acquaintances. Furthermore, our exposure variable—functional limitation—is measured by 15 questions related to activities of daily living and is believed to be a good proxy for the physical health status of older people (Spector & Fleishman, 1998). Finally, this study took into account various control variables at the individual and municipality level, which may reduce the risk of model misspecification. We believe our findings will contribute to a deeper understanding of the relationship between functional limitations and psychological well-being, highlighting the mediating role that SRP plays in this relationship among frail older adults.

This study is not without limitations. First, the data were obtained from a limited number of municipalities in Norway, which reduces the generalizability of the results. Second, frail older adults in general may have problems answering some questionnaires on key variables used in this study. Third, even if we controlled for a battery of several potentially relevant confounders, nevertheless, omitted variables, including unobservable individual characteristics, may still bias the reported results. Finally, our dataset comprised two time points—baseline and follow-up—which would potentially allow us to employ a longitudinal research design. However, our data was highly unbalanced, with a higher attrition rate due to loss to follow-up observed, particularly in the non-HCPC group. In our analyses, we therefore controlled for both time and whether the municipalities belonged to HCPC or non-HCPC as confounders. Future research should employ longitudinal data with larger sample sizes to expand on these findings for promoting healthy aging.

In conclusion, the functional capability of frail older adults is crucial to their mental well-being, with social interaction playing an important mediating role. Our findings suggest that approximately one-third of the total effect of functional limitation is mediated through social relationships, implying that functional limitation has a stronger direct effect on MWB after controlling for all covariates. The natural aging process

depreciates functional capabilities and may be unavoidable. However, healthy aging could improve older people's MWB either directly or indirectly through better social relationships. Thus, policymakers need to prioritize both functional limitations and social factors to improve MWB among older adults. As such, investments aimed at improving functional abilities and social relationships are important intervention channels through which MWB and overall quality of life of older adults can be enhanced.

Acknowledgements

The authors are grateful to many different organizations and individuals for their valuable support during the study initiation and data collection process. Our sincere thanks go to Sigrid Askum and Torun Risnes from the Norwegian Association of Local and Regional Authorities; Anders Vege from the Norwegian Institute of Public Health; Anders Grimsmo from Norwegian Health Network; research assistants, Runa Falck, Tord Lauvland Bjernevik and Nina Lunde; to all participating municipalities.

Ethical approval

The Regional Committee for Medical and Health Research Ethics has approved this study (2017/632-3). The study was conducted in accordance with the provisions of the Declaration of Helsinki (1996) and Good Clinical Practice guidelines.

Authors contributions

M. Kamrul Islam (MKI) and Admassu N. Lamu (ANL) conceptualized the study aims, design and methods with input from Jan Erik Askildsen (JEA). MKI and ANL conducted the statistical analysis and drafted the manuscript. Sabine Ruths (SR), Maureen Rutten-van Mölken (MRvM) and JEA reviewed and provided comments on the manuscript throughout the process. MKI, SR, MRvM & JEA contributed to the project administration, data curation and supervision. All authors approved the final version of the manuscript.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 634288. The funder had no role in the design of the study; in the collection, analysis, and interpretation of data; and in writing the manuscript. The content of this report reflects only the SELFIE groups' views, and the European Commission is not liable for any use that may be made of the information contained herein.

Data availability statement

The data that support the findings are not publicly available due to sensitive information that could compromise research participant privacy/consent. The collected data have been stored on a separate SAFE server ('Clinton') at the University of Bergen, with quality assured firewall and restricted, password-protected access. Only researchers associated with the project have access to these data. No one has access to the data in identifiable form.

References

- Aartsen, M. J., Van Tilburg, T., Smits, C. H., & Knipscheer, K. P. (2004). A longitudinal study of the impact of physical and cognitive decline on the personal network in old age. *Journal of Social and Personal Relationships*, 21(2), 249–266. <https://doi.org/10.1177/0265407504041386>
- Backe, I. F., Patil, G. G., Nes, R. B., & Clench-Aas, J. (2018). The relationship between physical functional limitations, and psychological distress: Considering a possible mediating role of pain, social support and sense of mastery. *SSM - Population Health*, 4, 153–163. <https://doi.org/10.1016/j.ssmph.2017.12.005>
- Berwick, D. M., Murphy, J. M., Goldman, P. A., Ware, J. E., Barsky, A. J., & Weinstein, M. C. (1991). Performance of a five-item mental health screening test. *Medical Care*, 29(2), 169–176. <https://doi.org/10.1097/00005650-199102000-00008>
- Bøen, H., Dalgard, O. S., & Bjertness, E. (2012). The importance of social support in the associations between psychological distress and somatic health problems and socio-economic factors among older adults living at home: A cross sectional study. *BMC Geriatrics*, 12(1), 27. <https://doi.org/10.1186/1471-2318-12-27>
- Brown, R. L. (2017). Understanding the influence of stigma and discrimination for the functional limitation severity - psychological distress relationship: A stress and coping perspective. *Social Science Research*, 62, 150–160. <https://doi.org/10.1016/j.ssresearch.2016.08.002>
- Cardol, M., de Haan, R. J., de Jong, B. A., van den Bos, G. A., & de Groot, I. J. (2001). Psychometric properties of the Impact on Participation and Autonomy Questionnaire. *Archives of Physical Medicine and Rehabilitation*, 82(2), 210–216. <https://doi.org/10.1053/apmr.2001.18218>
- Cardol, M., de Haan, R. J., van den Bos, G. A., de Jong, B. A., & de Groot, I. J. (1999). The development of a handicap assessment questionnaire: The Impact on Participation and Autonomy (IPA). *Clinical Rehabilitation*, 13(5), 411–419. <https://doi.org/10.1191/026921599668601325>
- Collaborators, G. M. D. (2022). Global, regional, and national burden of 12 mental disorders in 204 countries and territories, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019. *Lancet Psychiatry*, 9(2), 137–150. [https://doi.org/10.1016/S2215-0366\(21\)00395-3](https://doi.org/10.1016/S2215-0366(21)00395-3)
- Conner, K. A., Powers, E. A., & Bultena, G. L. (1979). Social interaction and life satisfaction: An empirical assessment of late-life patterns. *Journal of Gerontology*, 34(1), 116–121. <https://doi.org/10.1093/geronj/34.1.116>
- Costenoble, A., Knoop, V., Debain, A., Vermeiren, S., Vella Azzopardi, R., Rossi, G., Smeys, C., Baltazar, K. D., Bautmans, I., Verté, D., Gorus, E., & De Vriendt, P. (2022). Prefrailty: The relationship between daily activities and social participation in older persons. *Journal of Applied Gerontology*, 41(2), 430–440. <https://doi.org/10.1177/0733464821991007>
- Dawson-Townsend, K. (2019). Social participation patterns and their associations with health and well-being for older adults. *SSM - Population Health*, 8, 100424. <https://doi.org/10.1016/j.ssmph.2019.100424>
- De Belvis, A. G., Avolio, M., Sicuro, L., Rosano, A., Latini, E., Damiani, G., Ricciardi, W. (2008). Social relationships and HRQL: A cross-sectional survey among older Italian adults. *BMC Public Health*, 8, 1–10. <https://doi.org/10.1186/1471-2458-8-348>
- Demirer, I., Bethge, M., Spyra, K., Karbach, U., & Pfaff, H. (2021). Does social support mediate the effect of multimorbidity on mental wellbeing in the German working population? A longitudinal mediation analysis using structural equation modelling. *SSM - Population Health*, 13, 100744. <https://doi.org/10.1016/j.ssmph.2021.100744>
- Dettori, J. R., Norvell, D. C., & Chapman, J. R. (2018). The sin of missing data: Is all forgiven by way of imputation? *Global Spine Journal*, 8(8), 892–894. <https://doi.org/10.1177/2192568218811922>
- Elovainio, M., Hakulinen, C., Pulkki-Räback, L., Aalto, A.-M., Virtanen, M., Partonen, T., & Suvisaari, J. (2020). General Health Questionnaire (GHQ-12), Beck Depression Inventory (BDI-6), and Mental Health Index (MHI-5): Psychometric and predictive properties in a Finnish population-based sample. *Psychiatry Research*, 289, 112973. <https://doi.org/10.1016/j.psychres.2020.112973>
- Fastame, M. C., Hitchcott, P. K., & Penna, M. P. (2018). The impact of leisure on mental health of Sardinian elderly from the 'blue zone': Evidence for ageing well. *Ageing Clinical and Experimental Research*, 30(2), 169–180. <https://doi.org/10.1007/s40520-017-0768-x>
- Feng, D., Ji, L., & Xu, L. (2014). Mediating effect of social support on the association between functional disability and psychological distress in older adults in rural China: Does age make a difference? *PloS One*, 9(6), e100945. <https://doi.org/10.1371/journal.pone.0100945>
- Forsman, A. K., Herberts, C., Nyqvist, F., Wahlbeck, K., & Schierenbeck, I. (2013). Understanding the role of social capital for mental wellbeing among older adults. *Ageing and Society*, 33(5), 804–825. <https://doi.org/10.1017/S0144686X12000256>
- Fowler, J. H., & Christakis, N. A. (2008). Dynamic spread of happiness in a large social network: Longitudinal analysis over 20 years in the Framingham Heart Study. *BMJ (Clinical Research Ed.)*, 337(2), a2338–a2338. <https://doi.org/10.1136/bmj.a2338>
- Gunzler, D., Chen, T., Wu, P., & Zhang, H. (2013). Introduction to mediation analysis with structural equation modeling. *Shanghai Archives of Psychiatry*, 25(6), 390–394. <https://doi.org/10.3969/j.issn.1002-0829.2013.06.009>
- Hoeymans, N., Garssen, A. A., Westert, G. P., & Verhaak, P. F. (2004). Measuring mental health of the Dutch population: A comparison of the GHQ-12 and the MHI-5. *Health and Quality of Life Outcomes*, 2(1), 23. <https://doi.org/10.1186/1477-7525-2-23>
- Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, 6(1), 1–55. <https://doi.org/10.1080/10705519909540118>
- Huang, L. H. (2019). Well-being and volunteering: Evidence from aging societies in Asia. *Social Science & Medicine* (1982), 229, 172–180. <https://doi.org/10.1016/j.socscimed.2018.09.004>
- Huxhold, O., Miche, M., & Schüz, B. (2014). Benefits of having friends in older ages: Differential effects of informal social activities on well-being in middle-aged and older adults. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, 69(3), 366–375. <https://doi.org/10.1093/geronb/gbt029>
- Imamura, H., Hamano, T., Michikawa, T., Takeda-Imai, F., Nakamura, T., Takebayashi, T., & Nishiwaki, Y. (2016). Relationships of community and individual level social capital with activities of daily living and death by gender. *International Journal of Environmental Research and Public Health*, 13(9), 860. <https://doi.org/10.3390/ijerph13090860>
- Institute for Health Metrics and Evaluation. (2019). *The 2019 Global Burden of Disease (GBD) study*. University of Washington. <https://vizhub.healthdata.org/gbd-results/>
- Islam, M. K., Ruths, S., Jansen, K., Falck, R., Mölken, M. R.-v., & Askildsen, J. E. (2021). Evaluating an integrated care pathway for frail elderly patients in Norway using multi-criteria decision analysis. *BMC Health Services Research*, 21(1), 884. <https://doi.org/10.1186/s12913-021-06805-6>
- Jorm, A. F., Patten, S. B., Brugha, T. S., & Mojtabai, R. (2017). Has increased provision of treatment reduced the prevalence of common mental disorders? Review of the evidence from four countries. *World Psychiatry: Official Journal of the World Psychiatric Association (WPA)*, 16(1), 90–99. <https://doi.org/10.1002/wps.20388>
- Katz, S., Ford, A. B., Moskowitz, R. W., Jackson, B. A., & Jaffe, M. W. (1963). Studies of illness in the aged. The Index of Adl: A standardized measure of biological and psychosocial function. *JAMA*, 185, 914–919. <https://doi.org/10.1001/jama.1963.03060120024016>
- Kawachi, I., & Berkman, L. F. (2001). Social ties and mental health. *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, 78(3), 458–467. <https://doi.org/10.1093/jurban/78.3.458>
- Kelly, M. J., Dunstan, F. D., Lloyd, K., & Fone, D. L. (2008). Evaluating cut-points for the MHI-5 and MCS using the GHQ-12: A comparison of five different methods. *BMC Psychiatry*, 8(1), 10. <https://doi.org/10.1186/1471-244X-8-10>
- Kong, L. N., Hu, P., Yao, Y., & Zhao, Q. H. (2019). Social support as a mediator between depression and quality of life in Chinese community-dwelling older adults with chronic disease. *Geriatric Nursing*, 40(3), 252–256. <https://doi.org/10.1016/j.gerinurse.2018.10.014>
- Kool, M. B., van Middendorp, H., Lumley, M. A., Bijlsma, J. W., & Geenen, R. (2013). Social support and invalidation by others contribute uniquely to the understanding of physical and mental health of patients with rheumatic diseases. *Journal of Health Psychology*, 18(1), 86–95. <https://doi.org/10.1177/1359105312436438>
- Laan, W., Zuithoff, N. P. A., Drubbel, I., Bleijenbergh, N., Numans, M. E., De Wit, N. J., & Schuurmans, M. J. (2014). Validity and reliability of the Katz-15 scale to measure unfavorable health outcomes in community-dwelling

- older people. *The Journal of Nutrition, Health & Aging*, 18(9), 848–854. <https://doi.org/10.1007/s12603-014-0558-5>
- Lawton, M. P., & Brody, E. M. (1969). Assessment of older people: Self-maintaining and instrumental activities of daily living. *The Gerontologist*, 9(3 Part 1), 179–186. https://doi.org/10.1093/geront/9.3_Part_1.179
- Levasseur, M., Richard, L., Gauvin, L., & Raymond, E. (2010). Inventory and analysis of definitions of social participation found in the aging literature: proposed taxonomy of social activities. *Social Science & Medicine*, 71(12), 2141–2149. <https://doi.org/10.1016/j.socscimed.2010.09.041>
- Lloyd, H., Fosh, B., Whalley, B., Byng, R., & Close, J. (2019). Validation of the person-centred coordinated care experience questionnaire (P3CEQ). *International Journal for Quality in Health Care*, 31(7), 506–512. <https://doi.org/10.1093/intqhc/mzy212>
- Maltby, J., Hunt, S. A., Ohinata, A., Palmer, E., & Conroy, S. (2020). Frailty and social isolation: Comparing the relationship between frailty and unidimensional and multifactorial models of social isolation. *Journal of Aging and Health*, 32(10), 1297–1308. <https://doi.org/10.1177/0898264320923245>
- Mehrabi, F., Pomeroy, M. L., Cudjoe, T. K. M., Jenkins, E., Dent, E., & Hoogendijk, E. O. (2024). The temporal sequence and reciprocal relationships of frailty, social isolation and loneliness in older adults across 21 years. *Age and Ageing*, 53(10), afae215. <https://doi.org/10.1093/ageing/afae215>
- Miao, J., & Bierman, A. (2023). Functional limitations and psychological well-being among older adults in China: The critical role of hukou as a stratifying factor. *International Journal of Aging & Human Development*, 97(3), 327–353. <https://doi.org/10.1177/00914150221143997>
- OECD/European Observatory on Health Systems Policies. (2019). *Norway: Country health profile 2019, state of health in the EU*. OECD Publishing. <https://doi.org/10.1787/2e821540-en>
- Pan, C., & Yu, L. (2024). Bidirectional and dynamic relationships between social isolation and activities of daily living among older adults in China. *Journal of Global Health*, 14, 04031. <https://doi.org/10.7189/jogh.14.04031>
- Portegijs, E., Lee, C., & Zhu, X. (2022). Activity-friendly environments for active aging: The physical, social, and technology environments. *Frontiers in Public Health*, 10, 1080148. <https://doi.org/10.3389/fpubh.2022.1080148>
- Rosso, A. L., Taylor, J. A., Tabb, L. P., & Michael, Y. L. (2013). Mobility, disability, and social engagement in older adults. *Journal of Aging and Health*, 25(4), 617–637. <https://doi.org/10.1177/0898264313482489>
- Serrat, R., Scharf, T., Villar, F., & Gómez, C. (2020). Fifty-five years of research into older people's civic participation: Recent trends, future directions. *The Gerontologist*, 60(1), e38–e51. <https://doi.org/10.1093/geront/gnz021>
- Sirven, N., & Debrand, T. (2012). Social capital and health of older Europeans: Causal pathways and health inequalities. *Social Science & Medicine* (1982), 75(7), 1288–1295. <https://doi.org/10.1016/j.socscimed.2012.05.009>
- Spector, W. D., & Fleishman, J. A. (1998). Combining activities of daily living with instrumental activities of daily living to measure functional disability. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, 53(1), S46–S57. <https://doi.org/10.1093/geronb/53B.1.S46>
- Strand, B. H., Dalgard, O. S., Tambs, K., & Rognerud, M. (2003). Measuring the mental health status of the Norwegian population: A comparison of the instruments SCL-25, SCL-10, SCL-5 and MHI-5 (SF-36). *Nordic Journal of Psychiatry*, 57(2), 113–118. <https://doi.org/10.1080/0803948031000932>
- Sugavanam, T., Fosh, B., Close, J., Byng, R., Horrell, J., & Lloyd, H. (2018). Codesigning a measure of person-centred coordinated care to capture the experience of the patient: The development of the P3CEQ. *Journal of Patient Experience*, 5(3), 201–211. <https://doi.org/10.1177/2374373517748642>
- Syse, A., Thomas, M., Gleditsch, R. (2020). *Norway's 2020 population projections. National level results, methods and assumptions* [Report](2020/25). SSB. <https://www.ssb.no/en/befolkning/artikler-og-publikasjoner/norways-2020-population-projections>
- Ten Have, M., Van Bon-Martens, M. J. H., Schouten, F., Van Dorsselaer, S., Shields-Zeeman, L., & Luik, A. I. (2024). Validity of the five-item mental health inventory for screening current mood and anxiety disorders in the general population. *International Journal of Methods in Psychiatric Research*, 33(3), e2030. <https://doi.org/10.1002/mpr.2030>
- Tomioka, K., Kurumatani, N., & Hosoi, H. (2017). Age and gender differences in the association between social participation and instrumental activities of daily living among community-dwelling elderly. *BMC Geriatrics*, 17(1), 99. <https://doi.org/10.1186/s12877-017-0491-7>
- Tough, H., Siegrist, J., & Fekete, C. (2017). Social relationships, mental health and wellbeing in physical disability: A systematic review. *BMC Public Health*, 17(1), 414. <https://doi.org/10.1186/s12889-017-4308-6>
- Ware, J. E. (2002). *SF-12v2: How to score version 2 of the SF-12 health survey*. Quality Incorporated. QualityMetric Incorporated. <https://books.google.no/books?id=Ft4lvgAACAAJ>
- WHO. (2017). *Depression and other common mental disorders: Global health estimates*. World Health Organization. Retrieved February 12 from <https://www.who.int/publications/i/item/depression-global-health-estimates>
- WHO. (2019). *The WHO special initiative for mental health (2019-2023): Universal health coverage for mental health*. World Health Organization. Retrieved December 20 from <https://iris.who.int/handle/10665/310981>
- WHO. (2023). *Mental health of older adults*. World Health Organization. Retrieved March 29 from <https://www.who.int/news-room/fact-sheets/detail/mental-health-of-older-adults>
- Yang, Y. (2006). How does functional disability affect depressive symptoms in late life? The role of perceived social support and psychological resources. *Journal of Health and Social Behavior*, 47(4), 355–372. <https://doi.org/10.1177/002214650604700404>