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ORIGINAL RESEARCH

The Prediction of Successful Aging by Frailty, Functional Cognition and Well-Being in Community-Dwelling Older Adults: A Cross-Sectional Survey

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Introduction: It is widely recognised that frailty components and the functional cognition are associated with successful aging (SA). However, the true figures of this association are uncertain.

Purpose: To examine the prediction of SA by frailty, functional cognition and well-being in community-dwelling adults aged 65 years and over.

Patients and Methods: A convenience-sampling method in a cross-sectional design was used to recruit older people who received supportive care at an "Open Protection Centre for the Elderly" in Crete, Greece, from March to June 2023. SA was assessed using the Successful Aging Index (SAI) and frailty using the Tilburg Frailty Indicator (TFI), well-being was assessed with the WHO-5 questionnaire, and the functional cognition was assessed with the Functional Assessment Staging Tool (FAST). To predict Successful Aging, SAI was placed as a dependent variable, and FAST staging, TFI, and WHO-5 as independent variables, including sociodemographic characteristics.

Results: The mean age of the 178 participants (62.4% female) was 73.79 ± 5.41, and the frailty mean value was 6.88 ± 3.11 (range 0–15). Our sample experienced middle levels of SA (mean 54.64 ± 25.62 [range 6–95]) and well-being (mean 53.42 ± 24.66 [range 0–100]). The hierarchical linear regression model revealed that participants with physical (−2.41, $p<0.001$) and social frailty (−2.52, $p = 0.013$) are expected to present a significantly lower SA, even after adjusting for sociodemographic characteristics. Well-being was also predicted SA, suggesting that higher levels of well-being are associated with greater SA (0.27, $p<0.001$).

Conclusion: Our findings indicate that frailty, well-being and functional cognition predicted lower SA in community-dwelling older adults, highlighting the importance of community-based interventions led by interdisciplinary teams.

Keywords: successful aging, healthy ageing, functional cognition, frailty, well-being

Introduction

Successful aging (SA) is a multidimensional construct encompassing the domains of physical and psychological health, cognitive function and social engagement, incorporating both objective evaluation and subjective perspectives of older adults.[1,2] Worldwide, the prevalence rates of SA vary due to the lack of consistency in definitions of SA.[3] Currently, SA is assessed through multiple models incorporating physical, cognitive, and psychosocial domains, with prevalence 25.1% in Asia, 21.5% in Europe, 20.6% in the Americas, 16.8% in developed and 27.1% in developing countries.[4] Among

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European countries, 23.5% of adults >50 years old or older are characterised as successful aged, and this percentage increases to 38.9% when psychosocial factors are considered in addition to biological criteria. Yet, the prevalence of SA was higher in North-western European countries compared to Mediterranean and Eastern countries, whereas Greece held the last place.[5] Notably, the concept of SA is aligned with the initiatives and strategy on healthy ageing of both the World Health Organization (WHO) and the European Innovation Partnership on Active and Healthy Ageing (EIPonAHA), aiming to the improvement of health and quality of life of European citizens with a focus on functional ability, social networks, and daily life, functional capacity, to enable well-being and independence of older people.[6,7]

In contrast, frailty is also a multidimensional concept characterised by diminished physical, cognitive, and psychosocial capacity-affects a substantial proportion of community-dwelling older adults. Frailty is linked to physical disabilities, psychological and cognitive impairments and social disadvantages with adverse health outcomes. Specifically, physical adverse effects on mobility difficulties/falls, reduced performance in activities of daily living and thus loss of independence.[8,9] The prevalence of frailty among 42 European countries, demonstrating lower remarkable between-country heterogeneity and significantly higher frailty prevalence in less-developed European countries.[10] The prevalence of frailty in community-dwelling older adults is significantly higher compared to the general population, ranging between 12.2% and 24%, depending on the setting and definition of frailty.[11,12] Recent studies on the Greek community-dwelling older adults have indicated that the detrimental effect of frailty extends to the psychosocial realm, such as a decline in functional cognition, poor quality of life and heightened rates of loneliness.[13–15] Given the multidimensional nature of both successful aging and frailty, understanding how physical, cognitive, and psychosocial factors interact is essential for promoting healthy aging in community-dwelling older adults.

Most importantly, subjective well-being and functional cognition enable older adults to pursue valued activities, highlighting their key role in successful aging. Therefore, both SA and frailty recognise a continuum of aging from fitness to disability, encompassing multidimensional factors from narrow and mainly biomedical to psychosocial and subjective components.[16] However, SA examines the high end, whilst frailty predominantly examines the low end of the functioning spectrum.[17] Besides, as evident in WHO guidelines, there is a shift in the understanding of ageing from a focus on disease, impairment and disability to a broader emphasis on maintaining and improving functional ability and well-being.[6] Hence, functional ability, encompassing cognitive functionality, which empowers older individuals to pursue their valued goals and activities, is considered a key component of SA.[18] Additionally, this psychological construction of subjective well-being has received extensive attention not only because it relates to optimal experience and functioning across the lifespan, but also because it has gained significant focus in explaining how older adults cope with the challenges of aging.[19] Thus, the investigation of frailty components and associated factors in community-dwelling older adults may have a comparable ability to predict SA.

In Greece, SA has been explored mainly in relation to dietary and lifestyle patterns, yet the predictive role of frailty, functional cognition, and well-being remains underexplored.[20–22] The multidimensional nature of both SA and determined factors associated with frailty, such as cognitive decline and well-being in community-dwelling older adults, makes it important to explore how frailty and cognitive function may predict SA, taking into consideration the socioeconomic factors. Within a framework, the determination of frailty, functional cognition and well-being as predictive factors of SA will highlight the importance of detecting and managing the functional impairment stemming from frailty as well as promoting the implementation of appropriate interventions for the enhancement of SA by health professionals. Understanding these relationships could guide interventions to preserve independence, enhance quality of life, and promote active aging. Consequently, investigating the predictive role of frailty, cognitive function, and well-being on SA may provide actionable insights for early interventions to enhance well-being, including quality of life and functional independence among older adults.

Therefore, this study aimed to investigate the prediction of successful aging by frailty, functional cognition and well-being in community-dwelling people aged 65 years and over.

Materials and Methods

Study Design and Participants

The present study is a cross-sectional survey conducted in the region of Crete, Greece, from April to June 2023. A convenience sampling method was used to approach 215 older adults who were registered members of the "Open

Protection Centre for the Elderly" community program. However, membership is generally open to individuals based on age and residency, regardless of their economic status. This program provides various entertainment activities, medical care, physiotherapy, occupational therapy, social work, and instructions on medical treatment and operates under the auspices of municipal authorities throughout Greece.[23]

Sample Size Calculation

The sample size for the precision of the study was calculated with the G* Power 3 software (3.1.9.7). Considering a low effect size (f2 = 0.05), a precision level of 5% (alpha level), statistical power of 80%, and the total number of predictors as 14, a minimum sample size of 160 individuals was required.

Inclusion and Exclusion Criteria

After the licensing agreement to collect data, we recruited all registered members to participate in this screening program. Participants were eligible to participate if they:

1. were ≥65 years old;
2. ability and willingness to complete all study instruments;
3. provided their verbal informed consent.

Exclusion Criteria

1. participants who refused to participate;
2. participants with severe visual or hearing impairments and/or intellectual disabilities;
3. unable to fulfil the study instruments.

Although a total of 215 older adults were screened, full data from 178 individuals were finally involved in the statistical analysis (response rate 82.8%), as shown in Figure 1.

SA Assessment

The level of SA was assessed using the Successful Aging Index (SAI). SAI was previously developed by Cosco and his colleagues[24] based on a consolidation of systematic reviews of researchers' and older adults' definitions of SA and

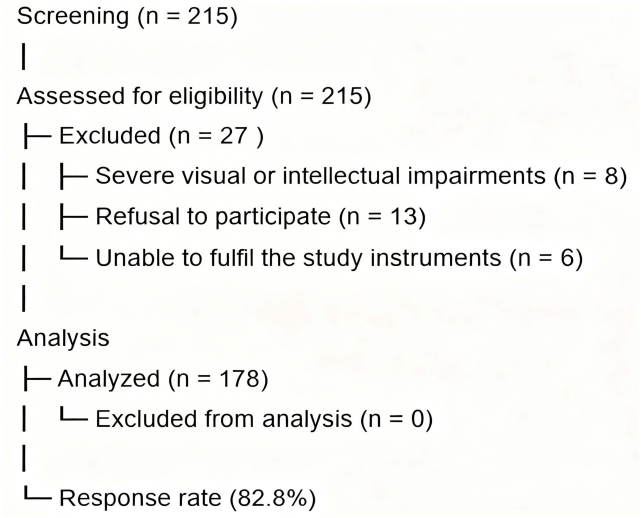

Figure 1 Participant's eligibility.
Notes: Consort Flow Diagram of the participant's eligibility and exclusion criteria.

comprises seven domains as follows: domains A and B are referred to as Engagement; C and D are referred to Personal resources; E is referred to assessment of cognitive functioning through the Mini Mental State Examination (MMSE) scores; F refers to the physical functioning related to the performance of the Activities of Daily Living (ADLs); and, G domain corresponding also to Instrumental Activities of Daily Living (IADLs) performance. Each domain consists of continuous values from 0 to 100. A total score of SAI is calculated by summing the mean values from the 7 domains divided by seven (A+B+C+D+E+F+G)/7. Higher values indicate a higher level of SA. Its practical utility and usefulness are based on AUC-adjusted models that showed strong predictive validity for community nurse use (AUC: 0.79 to 0.92) and (AUC: 0.61 to 0.69) for informal care. In our study, the reliability is $\alpha = 0.95$.

Frailty Assessment

Frailty assessment was performed using the Tilburg Frailty Indicator (TFI). Part B of the TFI encompasses 15 components of frailty, with 8 belonging to the physical domain, 4 to the psychological domain and 3 to the social domain.[25] Higher scores are indicators of a higher degree of frailty. The presence of physical frailty is determined by fulfilling at least 3 out of the 8 specified physical frailty components. Likewise, the determination of psychological frailty and social frailty requires the presence of at least 2 out of 4 and 2 out of 3 of the respective specified components.[26] The physical frailty components include poor physical health, unintended weight loss, difficulties in walking and maintaining balance, impaired hearing and vision, lack of hand strength and physical fatigue. Psychological frailty is assessed by the presence of memory problems, depression, feelings of anxiety, and the ability to deal with everyday problems. Finally, living alone, feelings of loneliness and inadequate social support were used as criteria for the evaluation of social frailty. Its concurrent validity was assessed by the area under the receiver operating characteristic curve (AUC).[27] For older Greek adults living in the community, the TFI physical domain showed (AUC 0.87), psychological domain (0.76), and social domain (0.71) using Pearson correlation confidence. Its internal consistency was assessed with the Cronbach alpha ($\alpha \geq 0.70$). In our study, the reliability of TFI was $\alpha = 0.81$.

Well-Being Assessment

The assessment of well-being was conducted with the use of the World Health Organization Well-Being Index (WHO-5), which is among the most widely used questionnaires assessing subjective psychological well-being. It includes 5 items scored from 5 (all of the time) to 0 (none of the time) and ranges between 0 and 25. Higher scores represent the best imaginable well-being. The WHO-5 has been applied in Greek older adults (mean age 64.05 ± 9.11 years old) with type 2 diabetes, showing acceptable internal consistency ($\alpha \geq 0.70$).[28] In our study, Cronbach's alpha was 0.98.

Functional Cognition Assessment

To examine whether possible functional changes in cognition may affect the prediction of SA, we used the Functional Assessment Staging Tool (FAST). The FAST evaluates functional abilities, including physical functional abilities, functional language abilities, functional activities such as mobility or feeding themselves, and contains 7 stages and delineates the characteristic pattern of progressive, sequential, and functional decline in dementia.[29] Each stage of FAST corresponds with an MMSE score, facilitating the cognitive ability to perform daily life tasks, integrating metacognition, executive function, and performance skills to accomplish everyday activities. In our study, to measure changes in functional cognition with the most accurate results possible, we divided participants into five equal groups for study purposes following the FAST stages. Notably, in this study, an unauthorised version of the Greek MMSE was used by the study team without permission; however, this has now been rectified with PAR. The MMSE is a copyrighted instrument and may not be used or reproduced in whole or in part, in any form or language, or by any means without the written permission of PAR.

Socioeconomic Assessments

Socioeconomic status was assessed by sex, age, education, marital status, residence, and annual individual income (<5,269€ defined as the poverty threshold) according to the Hellenic Statistical Authority.[30]

Ethical Considerations

The study protocol was ethically approved by the Scientific Committee of the MSc Program of the Hellenic Open University "Management of Aging and Chronic Diseases" (IRB: 10458/ 2 March 2023). Additionally, the local municipality authorities, by an "Open Protection Centre for the Elderly", provided the licensing agreement to collect data (Pr. No. 178/29 April 2022). The participants provided their informed verbal consent prior to the study's implementation, fully aware that their involvement was voluntary in accordance with the study protocol. Furthermore, the process ensured anonymity, and participants were granted the right to withdraw from the study at any time, in accordance with the General Data Protection Regulation (EU 2016/679) regarding sensitive personal information. Ethical concerns such as confidentiality and respect for basic patient rights were protected by the researchers following the Declaration of Helsinki.[31]

Statistical Analysis

Descriptive statistics were generated as appropriate for each variable. Categorical variables were summarised as frequencies (n) and percentages (%), while continuous variables were presented as mean and standard deviation (SD). Associations between sociodemographic characteristics, Functional cognition, Frailty, Well-being and level of SA were explored by one-way analysis of variance (ANOVA) for categorical variables and Pearson's correlation coefficient (*r*) for continuous variables. FAST Stage 1–2 used as reference category; TFI domains and WHO-5 scores as predictors; sociodemographic variables as covariates. A multivariate analysis (Hierarchical Linear Regression model) was performed to investigate the effect of predictive variables on SA (outcome variable). A p-value <0.05 was preset as statistically significant. Data were encoded and analysed using the IBM SPSS 26.0 software.

Results

In Table 1, the demographic characteristics of the study participants are presented. Briefly, the mean age of 178 participants (females 62.4%) was 73.79 ± 5.41, while 17.4% of them were aged ≥80 years old. Also, 36.5% of the participants had a primary educational level, 63.5% were married, and 80.9% lived under the poverty threshold. Additionally, the distribution of participants' functional cognition according to MMSE was also presented. Specifically, 31.5% of the participants were identified with severe dementia (MSSE scores 0–17), while 27.5% and 19.1% were recognised with moderate (MMSE score 18–21) and mild cognitive impairment (MMSE score 22–25), respectively. As far as the Functional cognition, 21.9% of the participants were categorised in Stage 1 or 2 (normal aging), 27.5% were allocated to Stage 4, and 22.5% to Stage 5. No participant was recognised in stage 7 (MMSE score 0–17).

Table 2 shows the mean scores and the reliability (Cronbach's Alpha) of the instruments that were used. In brief, the overall TFI reliability was (a=0.81) and mean score 6.88 with SD ± 3.11 and ranging 0–15, while the mean scores of TFI domains were: physical frailty (α=0.74), mean value 3.56±2.03 (ranging 0–8), psychological frailty (a=0.65), mean 2.08 ±0.97 (ranging 0–4) and social frailty (a=0.60), mean 1.24±0.88 (ranging 0–3). The reliability of the WHO-5 was 0.81, with a mean value of 53.42±24.66, ranging from 0–100, whereas the reliability of the SAI was 0.95, and the mean score was 54.56±25.62, ranging from 6–95.

In Table 3, the associations between sociodemographic characteristics of the participants, Frailty (TFI), Well-being (WHO-5) and Successful Aging Index (SAI) are presented. SA was significantly more frequent in individuals aged 65–79 years old compared to those ≥80 years old (61.05 vs. 24.26, p<0.001), in married individuals (61.13 vs. 43.36, p<0.001) and in participants with at least a secondary educational level (66.16 vs. 34.62, p<0.001). Furthermore, SA was significantly more frequent in participants who were living in urban regions (57.07 vs. 46.54, p=0.021) and in those who lived under the poverty threshold (56.97 vs. 44.77, p=0.012). Participants with physical frailty r −0.838, psychological frailty r −0.637, and social frailty r −0.468, p<0.001, experienced significantly lower levels of SA, respectively. SA significantly differed among functional cognition (moderately severe 17.04 ± 6.55 vs normal/possible mild 83.58 ± 9.55, p<0.00). Particularly, participants with severe cognitive dysfunction had significantly lower SA in comparison to

Table 1 Sociodemographic Characteristics, Cognitive Impairment, Functional Cognition and Frailty Status of the Participants (n=178)

Characteristics	Categories	n	%
Sex	Male	67	37.6
	Female	111	62.4
Age (years) [Mean ± *SD*: 73.79 ± 5.41]	65-79	147	82.6
	≥80	31	17.4
Marital Status	Married	113	63.5
	Single/Divorced/Widowed	65	36.5
Educational Level	Primary	65	36.5
	Secondary	93	52.2
	Tertiary	20	11.2
Annual Individual Income (Euros)	<5.269	144	80.9
	≥5.269	34	19.1
Place of Residence	Rural (<10,000 inhabitants)	41	23.0
	Urban (>10,000 inhabitants)	137	77.0
Cognitive Impairment (MMSE score)	26-30	39	21.9
	22-25	34	19.1
	18-21	49	27.5
	0-17	56	31.5
Functional Cognition (FAST)	Stage 1 or 2	39	21.9
	Stage 3	34	19.1
	Stage 4	49	27.5
	Stage 5	40	22.5
	Stage 6	16	9.0
	Stage 7	0	0.0

Notes: Functional cognition refers to the cognitive ability to perform daily life tasks, integrating metacognition, executive function, and performance skills to accomplish everyday activities according to MMSE scores.
Abbreviations: SD, standard deviation; FAST, Functional Assessment Staging Tool; TFI, Tilburg Frailty Indicator.

Table 2 Reliability of the Instruments TFI, WHO-5, and SAI (n=178)

Scales	Item Amount	Mean ± *SD*	Median	Range	Cronbach's Alpha
TFI					
Physical Frailty	8	3.56 ± 2.03	3.00	0 - 8	0.74
Psychological Frailty	4	2.08 ± 0.97	2.00	0 - 4	0.65
Social Frailty	3	1.24 ± 0.88	1.00	0 - 3	0.60
Overall Scale	15	6.88 ± 3.11	7.00	0 - 15	0.81
WHO-5	5	53.42 ± 24.66	60.00	0 - 100	0.98
SAI	17	54.64 ± 25.62	60.94	6 - 95	0.95

Abbreviations: SD, standard deviation; TFI, Tilburg Frailty Indicator; WHO-5, World Health Organisation – Five Well-Being Index; SAI, Successful Aging Index.

those at early stages. Conversely, participants with a higher level of well-being demonstrated a significantly higher level of SA (r=0.857, p<0.001).

In Table 4, we present the prediction of SA by frailty, well-being and functional cognition, placing TFI, WHO-5 and FAST as independent variables and sociodemographic characteristics as adjustment variables. Specifically, the functional

Table 3 Associations of Sociodemographic Characteristics, Functional Cognition (FAST), Frailty (TFI), and Well-Being (WHO-5) with Successful Aging (SAI)

Categorical Variables	**Mean ± *SD***	***F***	***p*-value**
Sex		0.073	0.787
Male	55.31 ± 26.41		
Female	54.24 ± 25.24		
Age (groups)		74.801	<0.001
65-79 years	61.05 ± 22.29		
≥80 years	24.26 ± 17.26		
Marital Status		22.261	<0.001
Married	61.13 ± 25.10		
Not Married	43.36 ± 22.56		
Educational Level		96.105	<0.001
Primary	34.62 ± 20.41		
Secondary or higher	66.16 ± 20.80		
Annual Individual Income (Euros)		6.437	0.012
<5.269	56.97 ± 25.96		
≥5.269	44.77 ± 21.84		
Place of Residence		5.466	0.021
Rural	46.54 ± 21.71		
Urban	57.07 ± 26.27		
Functional Cognition (FAST)		163.927	<0.001
Stage 1 or 2	83.58 ± 9.55		
Stage 3	72.27 ± 8.49		
Stage 4	52.40 ± 14.94		
Stage 5	29.23 ± 13.45		
Stage 6	17.04 ± 6.55		
Continuous variables		***r***	***p*-value**
Age (years)		−0.750	<0.001
TFI domains score			
Physical Frailty		−0.838	<0.001
Psychological Frailty		−0.637	<0.001
Social Frailty		−0.468	<0.001
WHO-5 score			
Well-Being		0.857	<0.001

Notes: Methods: Bivariate analysis, one-way analysis of variance (ANOVA) for categorical variables and Pearson's correlation coefficient (r) for continuous variables; Successful Aging (SAI score) placed as dependent variable; sociodemographic characteristics, Functional Cognition (FAST), Frailty domains (TFI scores), and Well-Being (WHO-5 score) as independent variables.

Abbreviations: SD, standard deviation; FAST, Functional Assessment Staging Tool; TFI, Tilburg Frailty Indicator; WHO-5, World Health Organization - Five Well-Being Index; SAI, Successful Aging Index.

cognition was found to have a significant predictive value on SA. Participants at stage 3 expect a significant reduction in SAI mean score (range 6–95) by 2.02 grades (p=0.018) compared to participants at stages 1 and 2 (reference category). Participants at stage 4 (2.14, p<0.001), stage 5 (3.04, p<0.001), and stage 6 (4.04, p<0.001) also expect a reduction in SAI mean scores compared to the reference category, respectively.

Table 4 Effect of Functional Cognition (FAST), Frailty (TFI), and Well-Being (WHO-5) on Successful Aging Index (SAI)

	Unadjusted (Model 1)					Adjusted (Model 2)				
	β	*SE*	Beta	*sr*	*p*-value	*β*	*SE*	Beta	*sr*	*p*-value
Intercept (*α*)	73.33	4.95			<0.001	81.57	14.65			<0.001
FAST (Stage 1 or 2 as reference category)										
Stage 3	−5.45	2.11	−0.08	−0.06	0.011	−4.81	2.02	−0.07	−0.06	0.018
Stage 4	−17.94	2.13	−0.31	−0.21	<0.001	−15.62	2.14	−0.27	−0.17	<0.001
Stage 5	−27.45	2.84	−0.45	−0.24	<0.001	−22.13	3.04	−0.36	−0.17	<0.001
Stage 6	−29.25	3.82	−0.33	−0.19	<0.001	−20.92	4.04	−0.23	−0.12	<0.001
TFI domains score										
Physical Frailty	−3.11	0.57	−0.25	−0.13	<0.001	−2.41	0.59	−0.19	−0.09	<0.001
Psychological Frailty	−1.62	0.95	−0.06	−0.04	0.089	−1.82	0.92	−0.07	−0.05	0.050
Social Frailty	−3.14	0.83	−0.11	−0.09	<0.001	−2.52	1.00	−0.09	−0.06	0.013
WHO-5 score										
Well-Being	0.27	0.05	0.26	0.13	<0.001	0.33	0.05	0.32	0.16	<0.001
Adjustment variables										
Sex (male vs. female)						−0.76	1.28	−0.01	−0.01	0.555
Age (years)						−0.41	0.19	−0.09	−0.05	0.027
Marital Status (married vs. not married)						−1.98	1.85	−0.04	−0.03	0.285
Education (primary vs. secondary or higher)						4.16	1.75	0.08	0.06	0.018
Income (<5.269€ vs. ≥5.269€)						7.16	1.77	0.11	0.09	<0.001
Place of Residence (rural vs. urban)						1.23	1.51	0.02	0.02	0.415

Notes: Methods: Multivariate analysis, Hierarchical Linear Regression model; SAI score placed as outcome variable; Functional Cognition, Frailty domains score, and WHO-5 score as predictor variables; sex, age, marital status, educational level, annual individual income, and place of residence as adjustment variables Model 1: F=186.715, $p<0.001$; $R^2=0.898$; Adjusted $R^2=0.894$ Model 2: F=122.540, $p<0.001$; $R^2=0.913$; Adjusted $R^2=0.906$.

Abbreviations: *SE*, standard error; *sr*, semi-partial correlation coefficient; FAST, Functional Assessment Staging Tool; TFI, Tilburg Frailty Indicator; WHO-5, World Health Organisation - Five Well-Being Index; SAI, Successful Aging Index.

Also, older adults with physical (−2.41, p<0.001) and social frailty (−2.52, p = 0.013) are expected to present a significantly lower level of SA, even after adjusting for sociodemographic variables. Psychological frailty was also significantly affecting the level of SA by −1.82 grades (p=0.050), although in Model 1 the association was not significant (−1.62, p=0.089).

As far as well-being, older adults with increased well-being were expected to have higher levels of SA (0.27, p<0.001) even after adjusting for sociodemographic characteristics (0.33, p<0.001).

Among the sociodemographic characteristics, significant associations were observed between age and SA (−0.41, p=0.027), suggesting that there is an expected decrease in SAI mean score (range 6–95) by −4.34 grades for each year increase in age. Also, participants with higher annual individual income ≥5.269€ (7.16, p<0.001) and higher educational level (4.16, p=0.018) are expected to present a higher level of SA compared to those with a lower annual individual income (<5.269€) and those with a primary educational level, respectively. No other significant associations were observed.

Discussion

Summary of Main Findings

In this study, we sought to investigate the prediction of SA by frailty, well-being and functional cognition, considering the socioeconomic status of a sample of community-dwelling older adults. Our data analysis showed that frailty across all domains of TFI (physical, psychological and social), functional cognition and well-being are significantly and independently associated with a lower SA. In addition, increased age was also associated with a lower SA, whereas higher educational levels and higher annual individual income were significantly associated with a higher SA.

Frailty and SA

Our findings that frailty predicts SA across physical, psychological, and social domains align with previous studies showing the impact of physical frailty on aging outcomes, even after adjusting for socioeconomic variables. Importantly, our study extends this evidence by emphasizing the psychosocial dimension as a critical contributor to SA. Most likely, frailty and SA, both multidimensional constructs, may overlap in physical consequences. For instance, physical limitations can reduce performance in daily activities, affecting both constructs.[9] Another possible explanation for these associations could be that frail older adults may present poorer SA due to unhealthy lifestyle choices[21] and the low end of the functioning spectrum.[17]

Notably, the effect of frailty on SA may exist due to the fact that Greece held the last place among southern European countries presenting a poorer SA,[5] whereas frailty was more frequent among these countries, including Greece.[10] Therefore, our findings highlight the fact that the assessment of frailty as a total but also as an individual domain in the evaluation of SA cannot be neglected. The existence of an effect of frailty on SA, as was found in our research, has been identified in several studies[32,33] in which the assessment of frailty has been carried out using the five criteria of physical frailty, offering evidence for the association between exclusively physical frailty and SA, misrecognizing the important, as evidenced by our findings, impact of the psychosocial domain of older adults in the achievement of SA.

Cognitive Function and SA

Our results indicate that cognitive decline, measured through functional staging, significantly predicts lower SA. This supports the concept of "Successful Cognitive Aging," where maintaining functional and cognitive abilities is critical for overall well-being in older adults. In comparison to our results, a recent study has shown that the severity of cognitive decline turns out to have a significant predictive value on SA, making it apparent that the achievement of SA's main role has not only the cognitive dysfunction but also the impact that limitations have on the daily functionality/autonomy of older adults.[34]

In our study, older adults with cognitive dysfunction across all stages presented with "poorer" SA compared to those with normal aging. These associations coincide with fundamental aspects of successful aging, such as cognitive impairment and functional decline. A recent study, considering the association between functional decline and failure of compensatory mechanisms, defined this complexity as "Successful Cognitive Aging" and examined three axes of geriatric medical situations related to cognitive function, highlighting the mechanisms relevant to working memory and executive function decline across normal aging.[35] Our finding is also supported by a recent study that explored the construct of cognitive successful aging, comparing two age groups, which showed that lifestyle practices that empower individuals and lifestyle choices in the context of cognitive aging.[36]

Well-Being and SA

High levels of well-being were associated with greater SA. These findings suggest that interventions promoting psychological well-being and social support may enhance SA outcomes. Similar findings were recently demonstrated by Cho and his colleagues[37] reporting that physical health impairment and cognitive functioning play important roles in the positive aspect of subjective well-being. Yet, the analysis focused on whether SA affects the level of well-being, finding a significantly positive association. This result may allow us to ensure the close association between well-being and SA, but also to hypothesise the existence of a bidirectional and mutually reinforcing relationship between these two geriatric conditions.[19]

Socioeconomic Factors and SA

Importantly, this study also demonstrates the effect of socioeconomic advantages on SA, suggesting that higher education and income were also associated with greater SA. Previous researchers have suggested that sociodemographic characteristics such as income and assets are significant factors in subjective well-being.[38,39] Moreover, a recent review article demonstrated that sociodemographic characteristics, social connectedness, and the built and community environment together interact with individual behaviour and attributes to promote or inhibit successful aging.[40] In our study, given that well-being is mainly used as an outcome in cross-sectional and longitudinal studies, we placed well-being as a predictor

of SA to examine whether well-being has a positive effect on SA according to our hypothesis. It is obvious, therefore, that socioeconomic factors such as educational level and income also highlight the fact that SA cannot be seen as an individual concept detached from the social context in which older adults live.

Implications for Practice and Policy

The concept of SA, since its inception, sought to identify protective factors and develop effective intervention strategies to foster the highest possible quality of life in older adulthood.[41] This represents a crucial advancement in aging research and initiatives that aim to cultivate and sustain the functional capacities necessary for the well-being of older adults, as exemplified by the World Health Organization's "Decade of Healthy Ageing" (2021–2030).[42] The traditional models, which primarily focused on maintaining health in old age as a criterion for SA, should be expanded to encompass a broader range of dimensions, such as social engagement and psychological well-being, taking into account the subjective understudying of older adults regarding what it means to age successfully. Therefore, the research and the strategies (individual or societal) should expand to capture the assessment of the holistic status of the older population (physical, mental-cognitive, psychological, social, functional). Also, to insert effective strategies such as adequate housing, mobility and other technology[43] and resources for aging not only in good health but also for ageing with disability and care needs. The enrichment of the knowledge of recent scientific evidence for the successful aging of health professionals will reinforce the implementation of care-related strategies and resources aiming at maintaining the care receiver's autonomy and well-being. In summary, health professionals and policy makers may focus on a wide range of initiatives designed to improve SA by:

- promoting holistic assessments of older adults, including physical, cognitive, psychological, and social domains;
- encouraging community-based interventions led by interdisciplinary teams;
- incorporating technology and resources to support independence and well-being.

Limitations

An important limitation of the present study is that the assessment scales for frailty, SA, cognitive function, and well-being are based on self-reports; therefore, the responses of the participants are subjective and not controlled by objective measurements. For instance, the MMSE scale shows low sensitivity in determining the cognitive function of subjects, both in mild cognitive impairment and between severe and very severe dementia. Likewise, in this study, we used the unauthorised version of the Greek MMSE. This may introduce information bias, mainly because the MMSE is sensitive to cultural, language, and education levels, so non-standard adaptations can inaccurately reflect cognitive ability, leading to incorrect measurements. Also, the educational level, the socio-economic level and the age of the respondents may affect their score in the MMSE.[44]

In addition, contextual factors such as post-COVID-19 effects may influence our results. For instance, the degree of frailty resulting from the statements of the elderly participants may have been affected by the significant physical and social burdens they have suffered due to the adverse conditions of the pandemic. Nevertheless, the collection of data in this specific period can provide particularly important data on the state of frailty and successful aging after experiencing the pandemic and its negative effects on the existing well-being and daily life.

Another potential limitation was the cross-sectional design, as it does not account for changes in variables over time. Nevertheless, we recognise that longitudinal research may be undertaken for the testing of changes in variables over time. We also cannot determine causality due to the observational nature and single-point data collection, for instance, to explain what caused those correlations. Sample collection was performed in a single community setting and, therefore, possibly did not allow the generalising of our findings compared to other national cohorts or longitudinal surveys. Finally, another potential limitation could be the low response rate that may bias our results. To counteract the bias, we applied the analysis of covariance and controlled for interaction effects (covariates), meaning that any bias from a low response rate was eliminated.[45]

Conclusion

Our findings indicate that frailty, well-being and functional status predicted lower SA in community-dwelling older adults. This represents a significant advancement in our understanding of factors associated with SA. Therefore, multidimensional assessment is essential in geriatric care. Community-based interventions and well-designed approaches by interdisciplinary teams can enhance SA and, therefore, are considered crucially important. Finally, our findings suggest the need for longitudinal or interventional follow-up studies to confirm predictive interactions.

Data Sharing Statement

The data presented in this research are available on request from the corresponding author. The data is unavailable to the public due to privacy limitations.

Institutional Review Board Statement

Ethical approval was obtained from Hellenic Open University (# 10458 and the local municipality authorities by an "Open Protection Centre for the Elderly", Crete Island, Greece (# 178).

Informed Consent Statement

Informed verbal consent was obtained from all participants.

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An unauthorized version of the Greek MMSE was used by the study team without permission, however this has now been rectified with PAR. The MMSE is a copyrighted instrument and may not be used or reproduced in whole or in part, in any form or language, or by any means without the written permission of PAR.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agreed to be accountable for all aspects of the work.

Disclosure

The authors declare no conflicts of interest in this work.

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