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Validation of an integrative multidimensional model of successful aging in community-dwelling older adults: what is successful aging all about?

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Abstract
The concept of successful aging has raised much debate and intrigued researchers for over four decades. However, a consensus regarding its definition and measurement has not yet been reached, which narrates the main impediment of successful aging research. The main goal of this study was to validate a proposed multidimensional model of successful aging, with its five components: physiological/physical, cognitive, psychological/emotional, social, and subjective self-rated successful aging. A community-dwelling sample of 790 older adults living in the Republic of Croatia participated in the study, but the final analyzes were conducted on a sample of 767 participants, aged 65 to 98 years ($M = 73.86$ years, $SD = 6.53$), 58.8% of which were women. The construct validity of the proposed 5-component model was tested using a confirmatory factor analysis, and by comparing the model with several other theoretical models with 2, 3 or 4 components of successful aging. Results showed that the 5-component model fits the data the best thus confirms the multidimensional nature of successful aging. Partial metric invariance of the structure of the proposed model was found for younger and older age groups, and full metric invariance was established for both gender groups. This 5-factor model is a step forward in the development of a sound and comprehensive multidimensional definition of successful aging. Clear and comprehensive conceptualization of the successful aging construct is important, not only for research purposes, but also within the context of its practical application in developing policies which promote successful aging.

Keywords Construct validity · Factor analysis · Healthy aging · Older adults · Successful aging

Introduction

The fascinating changes in the length and quality of life in late adulthood have redirected the scientific interest from chronic conditions and decline evidenced in the old age towards more positive aspects of aging, such as maintenance of functions and life quality in later life. In the context of these positive perspectives on aging, terms like successful, active, healthy, vital, productive, quality aging, and similar have appeared (Bowling, 2007; Depp & Jeste, 2006; Fernandez-Ballesteros et al., 2013). These terms often overlap, for they all refer to the basic idea of aging well (Fernandez-Ballesteros et al., 2013). In comparison to other similar concepts, successful aging (SA) is the concept used the most in gerontological research. SA represents an umbrella term which includes healthy, active, and productive aging (Fernandez-Ballesteros et al., 2013; Fernandez-Ballesteros, 2019; Urtamo et al., 2019). The concept of SA has raised much debate (Katz & Calasanti, 2015; Urtamo et al., 2019) and has become one of the most controversial topics in gerontology. Since its popularization in the late 1980s (Rowe & Kahn, 1987), various studies have employed an immense number of different

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definitions and operationalizations of SA (Cosco et al., 2015; Parslow et al., 2011; Pruchno et al., 2010; Young et al., 2009). However, a consensus regarding its definition and measurement has not yet been reached. This status has become the main impediment of the SA research, limiting the generalizability and comparability of different SA studies. Therefore, in this study we have proposed and made initial attempts to test the construct validity of an integrative multidimensional model of SA. The proposed model captures crucial components and dimensions of SA identified in previous research and in the most prominent SA models.

Existing conceptualizations and measures of SA are primarily based on either biomedical (e.g., Rowe & Kahn, 1997) or psychosocial (e.g., Baltes & Baltes, 1990) approach. *The biomedical approach*, which hosts the most influential model of SA to date (Rowe & Kahn, 1987), continues to dominate the field. This classic model emphasizes the importance of preserved health and maintenance of physical, cognitive and social functioning at a high level in order to age successfully. Corroborating this, public health programs place the emphasis on extending the number of one's healthy years, and on preserving everyday functional ability and independence as long as possible (Fernandez-Ballesteros & Pinquart, 2011; Fries, 1980). Within the biomedical framework SA is examined objectively, for example, as a presence/absence of chronic health problems, ability to perform activities of daily living, or via cognitive status assessment. Criticism of this approach appeared due to the rigid criteria for SA, which can be met by only a small proportion of older people. Namely, advanced age without chronic diseases and functional limitations is almost impossible, especially among the oldest old. This is best shown by studies of centenarians (Anderson-Ranberg et al., 2001; Cho et al., 2012). Furthermore, the biomedical approach is being criticized for neglecting other important components of SA, such as psychosocial and spiritual (Bowling & Dieppe, 2005; Young et al., 2009). This approach was also objected for neglecting older people's subjective appraisals of SA, which are often more favorable than SA estimates based on the objective biomedical criteria (Bowling & Iliffe, 2006; Stewart et al., 2019). Evidence suggests that even people with serious health conditions can consider themselves successful agers if they manage to compensate the physiological and functional decline through good psychosocial functioning, and a sense of satisfaction and meaning in life (Young et al., 2009).

The psychosocial approach to SA emphasizes the importance of life satisfaction and other aspects of well-being, good social relationships, and psychological resources for SA (Baltes & Baltes, 1990; Bowling, 2007). One of the leading psychological models of SA, the model of selective optimization with compensation (Baltes & Baltes, 1990), describes SA as a process of successful adaptation to changes and loses in aging, by using behavioral and psychological processes of selection, optimization, and compensation. In research based on the psychosocial approach, SA is examined via measures of life satisfaction, subjective well-being, social participation and personal resources (e.g., resilience, self-efficacy, optimism, adjustment). Psychosocial conceptualizations have been supplemented with *lay perspective* of SA since scientists have realized their importance (Jopp et al., 2015) and relevance in shaping public health policies and practical interventions in promoting SA (Bowling & Dieppe, 2005; Bowling, 2006). Lay conceptions of SA are mostly captured by the qualitative methods or by asking older people how do they perceive SA and its related factors. Studies have shown that older people report numerous components and indicators of SA, which somewhat vary cross-culturally; their views on SA seem to be more complex compared to researchers' conceptualizations (Bowling, 2006; Jopp et al., 2015; Tucak Junaković & Ambrosi-Randić, 2022). A recent meta-analysis of lay conceptions of SA across 13 countries, in the period from 2010 to 2020, has showed that older people most often report social engagement and positive attitude as components of SA, aside from the components of independence and physical health (Reich et al., 2020).

Comprehensive reviews of SA literature underline a wide range and large inconsistencies in conceptualization and operationalization of SA, as well as growing research interest for this concept. For example, Depp and Jeste (2006) found 29 definitions of SA across 28 quantitative studies, while some years later Cosco et al. (2014) found even more – 105 different operational definitions of SA in 84 studies. In the latter review biomedical operational definitions took the lead (with a prevalence of 92.4%). In the meta-analysis of the SA correlates, Kim and Park (2017) have identified four behavioral domains associated with SA: avoiding disease and disability, having high cognitive/mental/physical function, active life engagement, and good psychological adaptation in later life. Depending on the theoretical conceptions and the derived measures of SA, an estimated proportion of successful agers vary extremely across different studies, in the range from less than 1 to over 90% (Cosco et al., 2014).

Recent studies have seemingly come to an agreement regarding the multidimensional nature of SA. A shift of focus from the biomedical perspective towards the psychosocial adaptation processes and subjective dimension of the aging process can be observed (Urtamo et al., 2019). Recently proposed multidimensional models and operationalization of SA are holistically oriented and include both, biomedical and psychosocial components

thus use objective measures and subjective assessments (Cosco et al., 2015; Kleineidam et al., 2019; Kok et al., 2017; Parslow et al., 2011; Pruchno et al., 2010; Vahia et al., 2012; Young et al., 2009). For example, Young et al. (2009) have proposed a multidimensional model that includes a physiological, psychological, and social component, while Pruchno et al. (2010) have proposed a two-factor SA model with subjective and objective component. Objective success is operationalized via a number of chronic conditions, functional ability, and pain assessment. Subjective SA is assessed by asking respondents how successfully they have aged, how well they are aging, and how they would rate their current life. Vahia et al. (2012) expanded the latter model by adding cognitive ability, mood, and psychosocial traits that they postulate to be closely related to SA (i.e., resilience, self-efficacy, optimism, and attitude toward own aging). Empirical validation of this extended *model of successful cognitive and emotional aging* has identified five latent components: self-rated SA, cognitive status, psychosocial protective factors, physical functioning, and mental/emotional status (Vahia et al., 2012). In their holistic operational definition of SA, Kok et al. (2017) have used nine indicators within the physical, cognitive, emotional and social domain. Similarly, Kleineidam et al. (2019) have suggested that well-balanced SA operationalization includes measures of physiological health and functioning, well-being, and social engagement. The recent model of SA– *aging-well* by Fernandez-Ballesteros (2019)– also considers biomedical components (i.e., health and activities of daily living, physical function, and cognition) and psychosocial factors (i.e., positive affect and good psychological adaptation, and engagement in social and productive activities), within the subjective and objective dimensions.

In our opinion, the most prominent conceptualizations and operational definitions of SA in the previous literature are presented in Table 1.

The present study

Still it seems that none of the proposed theoretical models of SA reflects the complexity of SA construct well enough. Further along, previous studies on SA reflect conceptual confusion with same constructs sometimes being treated as predictors, components, or sometimes as SA outcomes/criteria (Cosco, 2015). Upon a comprehensive review of the literature, as well as the existing models of SA, we here propose an integrative multidimensional model (Fig. 1). Due to its comprehensiveness, we believe it could surpass the specifics of various sociocultural settings. The model represents the integration of the most clearly supported components and dimensions of SA identified in the previous studies, as well as in the most prominent SA models (Cosco et al., 2015; Fernandez-Ballesteros, 2019; Kleineidam et al., 2019; Pruchno et al., 2010; Rowe & Kahn, 1987; Vahia et al., 2012; Young et al., 2009). These components are physiological/physical, cognitive, psychological/emotional, social component, and self-rated SA. At the same time, all the characteristics previously shown to be related to SA, but we see them more as determinants or potential predictors rather than its components (e.g., good finances, lifestyle factors, frequency of social contacts or personal resources such as optimism and resilience), were not included in the proposed model.

This study was conducted within the broader research project exploring the characteristics of living and aging in older people in Croatia, as its second quantitative phase. In the first qualitative phase we have investigated the perception of SA and its contributing factors. We intended to supplement the model proposed in Fig. 1 with components of SA that would emerge in the qualitative phase as those important for understanding SA in Croatian cultural context, but might have been omitted in previous model. We have assumed that key components of SA do not vary greatly cross-culturally. But we have also expected that, compared to Western European countries, some cultural specificities of Croatia, as Southeastern European county with socialist heritage, will emerge in Croatian older people's lay definitions of SA. Precisely, we expected that Croatian people will place more emphasis on the importance of collectivist values, such as social connectedness and social participation, for SA compared to people from Western cultural background. However, our qualitative study did not reveal any additional components or determinants of SA, above those identified in previous studies (Tucak Junaković & Ambrosi-Randić, 2022).

Adequate and comprehensive conceptualization of SA is extremely important, not only for research purposes, but also in the context of using the results of SA studies in promoting policies fostering SA. Therefore, the main goal of this study, conducted within the second quantitative phase of our research project, was an initial attempt of validation of proposed integrative multidimensional model of SA, i.e. an initial attempt of testing its construct validity. We primarily intended to validate its hypothesized theoretical structure, using previously developed and validated or newly constructed measures for capturing specific SA components. In this phase, our goal was not the development of the new instrument that would measure SA with its five components, according to the proposed model. However, this could be the goal of some future research.

Table 1 The most prominent conceptualizations and operational definitions of successful aging construct across various studies

Theoretical approaches/ models(examples of studies attempting to operationalize the model or offering propositions how to measure successful aging components)	Successful aging components	Operational definitions proposed or used by the authors of the model or used in other studies some of which are cited in the first column of the table
BIOMEDICAL / Rowe and Kahn's (1997) model of successful aging (Hodge et al., 2013; Meng & D'Arcy, 2014; Ng et al., 2009; Pruchno et al., 2010; Rowe & Kahn, 1997; Vahia et al., 2012, etc.)	Avoiding disease and disability	Presence/absence of chronic conditions (arthritis, hypertension, diabetes, cancer, heart disease, lung disease, stroke, osteoporosis, Parkinson's disease, etc.) or the number of chronic conditions
	High cognitive and physical function	Self-assessment of the ability to perform physical activities (standing in one place for a long time, climbing stairs, bending, walking, reaching, lifting or carrying small loads, etc.), self-rated chronic problems associated with the disease (e.g. pain, insomnia, falls), measures of functional ability such as the Activities of Daily Living Scale (ADLS, Katz et al., 1970) or the Instrumental Activities of Daily Living Scale (IADLS, Lawton & Brody, 1969), measures of cognitive status such as the Mini-Mental State Examination (Folstein et al., 1975)
	Engagement with life	Questions aimed at assessing social engagement or involvement in activities in the community such as volunteering, questions that assess frequency of contacts with friends and relatives or their support
PSYCHOSOCIAL / Model of selective optimization with compensation (Baltes & Baltes, 1990) (Baltes & Baltes, 1990; Bowling, 2007; Bowling & Dieppe, 2005, etc.)	Life satisfaction and other aspects of well-being, and personal resources such as self-growth, self-esteem, self-efficacy, optimism, resilience, autonomy, personal control, efficient coping strategies, selective optimization with compensation strategies, sense of purpose, etc.	Measures of life satisfaction, subjective well-being, and personal resources, such as resilience, self-efficacy, optimism, adjustment to aging process, etc. (e.g., Satisfaction with Life Scale (SWLS, Diener et al., 1985), The Connor-Davidson Resilience Scale (CD-RISC, Connor & Davidson, 2003), Self-Efficacy Scale (SES, Sherer et al., 1982), Life Orientation Test-Revised (LOT-R, Scheier et al., 1994), the Center for Epidemiological Studies Depression Scale (CES-D, Radloff, 1977), etc.; one or several items designed to asses life satisfaction, emotional vitality, meaning in life or other dimensions of successful aging)
	Good social functioning and quality social relationships	Measures of social participation or social support- most often questions designed by the authors of studies to measure social inclusion, frequency of social contacts, or received social support
LAY DEFINITIONS (Bowling, 2006; Cosco et al., 2013; Jopp et al., 2015; Reich et al., 2020; Reichstadt et al., 2007; Reichstadt et al., 2010; Tucak Junaković & Ambrosi-Randić, 2022, etc.).	Numerous and diverse components, including physical health and functioning, independence, social relationships, social engagement, positive attitude, self-acceptance, self-growth, the ability to adapt to change, meaning in life, spirituality, financial security, living conditions, etc.	These are qualitative studies mostly using interviews with older people to explore their definitions of successful aging and related factors. They do not adress the problem of operationalization or measurement of successful aging components.
New Generation Multidimensional and Holistic Models		

Table 1 (continued)

Multidimensional model of successful aging (Young et al., 2009)	Physiological	Young et al. (2009) propose using comorbidity and functional impairments measures. Comorbidity captures the 18 chronic conditions most prevalent among older people: angina, myocardial infarction, congestive heart failure, peripheral arterial disease, hip fracture, osteoporosis, osteoarthritis of hands, osteoarthritis of knees, osteoarthritis of hips, rheumatoid arthritis, disc disease, spinal stenosis, stroke, Parkinson's disease, pulmonary disease, diabetes, hypertension, and cancer. Authors suggest to use either continuous comorbidity variable by summing the 18 chronic conditions, or a dichotomous variable created based on the distribution of the data. Authors suggest to assess difficulty in performing 7 physical activities (standing for long periods, lifting or carrying weights of approximately 10 pounds, going up and down stairs, walking, stooping/bending/kneeling, using hands and fingers, reaching with either/or both arms) to measure functional impairments.
	Psychological	Young et al. (2009) consider that psychological component should include cognitive function, emotional vitality, and geriatric depression. They suggest using Mini-Mental State Examination (MMSE) for assessing cognitive status, and the Geriatric Depression Scale (GDS, Yesavage et al., 1982–1983) to capture depression. Authors did not specify measure of emotional vitality but they stated that emotional vitality is defined as having a high sense of personal mastery, being happy, and having low anxiety.
	Sociological	Authors of the model propose to assess the degree of interaction with the environment and social engagement by 5 questions addressing: satisfaction with contribution to community, neighborhood, religious, political, or other groups, satisfaction with how one is respected by others, satisfaction with the amount of variety in life, satisfaction with the help received from others, and satisfaction with the help given to others. They also propose to measure construct of spirituality as part of sociological component, using the Spirituality Index of Well-Being (SIWB, Ellison, 1983)
Two-factor model of successful aging (Pruchno et al., 2010)	Objective component	Objective success is operationalized via chronic conditions, functional ability, and pain assessment. Authors of the model used the sum of chronic conditions among eight conditions that are typically associated with older age (arthritis, hypertension, a heart condition, cancer, diabetes, osteoporosis, stroke, and lung conditions). Functional ability was assessed by reporting the amount of difficulty in performing four activities (walking for a quarter of a mile, walking up 10 steps, standing for 2 h, and stooping) on a 5-point Likert scale ranging from 1 (*cannot do it at all*) to 5 (*not at all difficult*). Pain was measured with three questions ("How often are you troubled with pain?", "How bad is the pain most of the time?", and "How often does the pain make it difficult for you to do your usual activities such as household chores or work?" with the 4-point Likert scale from 0 (*low*) to 3 (*high*) pain.
	Subjective component	Subjective component is assessed by asking respondents to evaluate on a scale from 0 to 10 how successfully they have aged, how well they are aging, and how they would rate their life these days.
Dimensional model for successful cognitive and emotional aging (Vahia et al., 2012)– expanded Pruchno and colleagues' model with added components of cognitive ability, mood, and psychosocial traits	Self-rated successful aging	Self-rated level of successful aging on a 10-point Likert scale, from 1 (*least successful*) to 10 (*most successful*)
	Physical functioning	SF-36 Physical Composite (Ware Jr & Sherbourne, 1992)
	Emotional/mental functioning	SF-36 Mental Composite (Ware Jr & Sherbourne, 1992)
	Self-Efficacy	Self-Efficacy Scale (SES, Sherer et al., 1982)
	Optimism	Life Orientation Test (LOT, Scheier et al., 1994)
	Attitude towards own aging	The Attitude Toward Aging subscale of the Philadelphia Geriatric Morale Scale (PGMS, Lawton, 1975; Kavirajan et al., 2011)
	Resilience	Connor Davidson Resilience Scale (CD-RISC, Connor & Davidson, 2003)
	Depression	Center for Epidemiological Studies Depression Scale (CES-D, Radloff, 1977)
	Cognitive status	Cognitive Assessment Screening Tool (CAST, Drachman & Swearer, 1996)
Multidimensional model of successful aging (Parslow et al., 2011)	Self-assessed physical health	Assessment on a 5-point scale ranging from *excellent* to *poor*
	Self-assessed mental health	Assessment on a 5-point scale ranging from *excellent* to *poor*
	Life satisfaction	Delighted-Terrible Scale (Andrews & Withey, 1976; according to Parslow et al., 2011)
	Cognition	Mini-Mental State Examination (Folstein et al., 1975)

Table 1 (continued)

A priori index model of successful aging (Cosco et al., 2015)	Physical functioning	Activities of daily living assessed with modified Katz ADLs (Katz et al., 1970), and instrumental activities of daily living assessed with modified Lawton IADLs (Lawton & Brody, 1969)
	Cognitive functioning	Mini-Mental State Examination (MMSE)
	Personal resources (optimism, engagement, loneliness, and self-awareness)	Optimism was measured on a three-point Likert scale ranging from optimistic to pessimistic view of the future. Engagement was assessed with a three-point Likert scale ranging from no loss of interest to persistent lower interest. Loneliness was measured on a three-point Likert scale ranging from no feelings of loneliness to frequent/persistent feelings of loneliness. Self- awareness was assessed by measure of self-rated health (four-point Likert scale ranging from excellent to poor assessment of one's own health). Results on all items were used to create the Successful Aging Index (SAI).
Fernandez-Ballesteros (2019)	Biomedical components (health and activities of daily living, physical function, and cognition) Psychosocial components (good psychological adaptation and active engagement in life)	Various validated measures of specific dimensions of these two broader components of successful aging could be used for the purpose of their operational definition.

Method

Participants

The study was conducted on a community-dwelling sample of 790 older adults (460 women, i.e. 58.23%), aged 65 to 98 years ($M = 73.97$, $SD = 6.58$), living in Croatia. Inclusion criteria were the age of 65 years or older, not living in an institution, and not having major cognitive impairments. Only 23 participants (2.9%) have checked the list of medical conditions for dementia. Given the small number in the overall sample, we decided to exclude the participants with diagnosed dementia. Analyzes were conducted on a sample of 767 participants (451 women, i.e. 58.8%), aged 65 to 98 years ($M = 73.86$, $SD = 6.53$). Most of participants were married (64%) or widowed (29%); have either lived with their spouse (44%) or alone (22.7%). Among them 19.8% have lived in an extended family with spouse and children, and 11.8% lived with their children alone. Almost all (96.7%) have lived in their own home. Regarding education, the majority has finished high school (45.1%), 28.2% participants had completed or partially completed elementary school, and 26.7% of participants had a university degree. Most participants were living in the cities (64.2%), while 18.3% were living in smaller towns/communities, and 17.5% in rural areas. Data were collected from participants living in a total of 48 cities, 57 smaller towns, and 51 rural areas across the Republic of Croatia.

Measures

All instruments used in this study were administered in the Croatian language. Most are original instruments, translated in Croatian. Two scales are new instruments, constructed for the purpose of this study.

In the introductory part of the questionnaire, a demographic information form was used. We collected data on participants' gender, age, level of education, marital status, living arrangement, place of living, and number of children.

Physiological/physical component of the proposed SA model is operationalized via: (1) the number of existent chronic health conditions, (2) ability to perform activities of daily living, and (3) self-rated health.1)

Chronic conditions (CC) were examined by asking respondents whether they have any of the health problems from the list of conditions most prevalent in older population (i.e., hypertension, heart condition, arthritis, diabetes, cancer, osteoporosis, stroke, lung condition; besides, depression, and dementia have been added to the list). Participants could also add other conditions they had and which were not mentioned in the list.

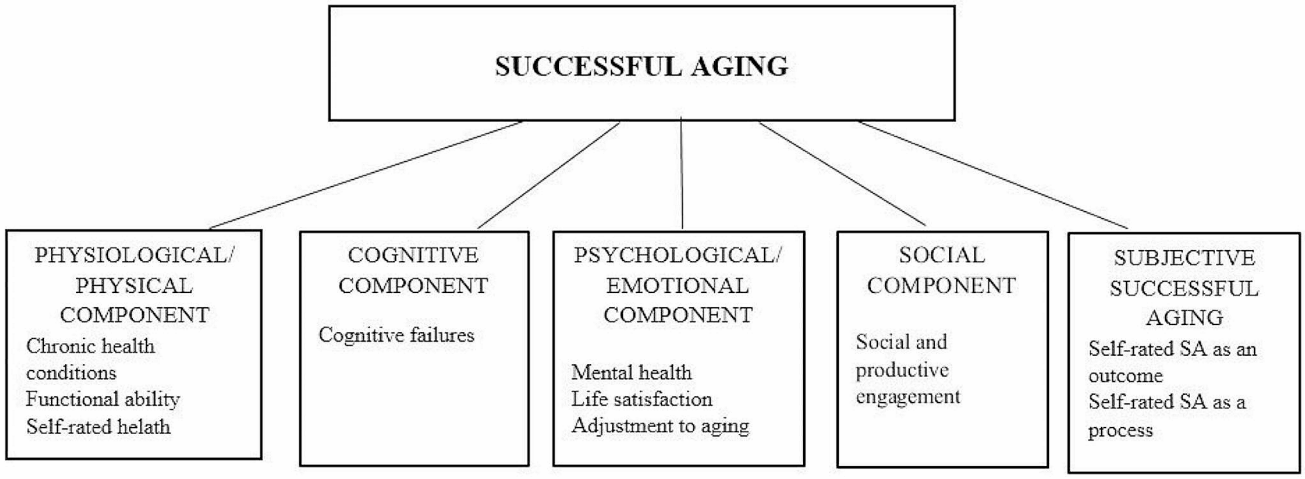

Fig. 1 Components of an integrative multidimensional model of successful aging

2) Activities of Daily Living Scale (ADL - Shanas et al., 1968; according to Despot Lučanin, 1997) measures functional ability by examined 14 activities of daily living (e.g., using stairs, walking at least 400 m, washing and bathing, cooking). For each activity participants assessed the degree of independence or difficulty in performing them, using a scale from 1 (cannot do it at all) to 4 (can do it without difficulty). The total score is a sum of assessments on all 14 activities, with a higher score indicating better functionality. This scale showed high reliability (Cronbach alpha of 0.92).
3) Self-rated health (SRH) was examined using one question (*"How would you rate your current health?"*) with a 5-point assessment scale (from 1-very poor to 5-excellent).

The *cognitive component* operationalizes cognitive functioning in aging. Cognitive Failures Questionnaire-Abbreviated (CFQ-short; Wilhelm et al., 2010) was used as a measure of cognitive failures in everyday functioning. It is a self-report measure of cognitive lapses, minor errors and omissions that disrupt the performance of intended everyday actions. In an earlier study (Martinčević et al., in preparation) on another sample of Croatian elderly people, we found that this questionnaire contains two factors– Clumsiness (CFQ-CL) and Memory distractibility (CFQ-MEM). Participants respond to each of the 12 items on a 5-point rating scale ranging from 0 (never) to 4 (very often), with higher score indicating a greater number of cognitive failures. Cronbach alpha coefficient for the whole scale obtained in this study was 0.88.

Psychological/emotional component included indicators of: (1) mental health, (2) life satisfaction, and (3) adjustment to aging process.1) Mental Health subscale (MH) from the Medical Outcomes Study Short Form (SF-36; Ware Jr & Sherbourne, 1992; Croatian adaptation - Maslić Seršić & Vuletić, 2006) assesses mental health. The SF-36 instrument is a 36-item multidimensional indicator of overall health, which assesses eight health domains, including emotional well-being or mental health. The mental health subscale consists of five items referring mostly to feelings of anxiety, depression and stress. The total score is expressed as a value ranging from 0 to 100, where a higher result indicates better mental health. Cronbach's alpha coefficient obtained in this research was 0.85.

2) Satisfaction with Life Scale (SWLS; Diener et al., 1985) is a well-known a 5-item scale which assesses a person's global evaluation of his or her own life. Participants indicate their agreement with each of the 5 items using a 7-point scale (1-strongly disagree to 7-strongly agree). The total score is the average of assessments on all 5 statements, where a higher score indicates higher life satisfaction. The scale showed high reliability (Cronbach alpha = 0.87).
3) Adjustment to Aging Scale (AAS) is a newly constructed short scale measuring the adjustment to aging process. The scale initially contained 4 items. Due to its low internal consistency and a puzzling factor structure only two items were kept in the final version (*"Aging has not brought me anything good."*, and *"The difficulties that come with age significantly impede my life."*). This curtailment has somewhat increased its modest reliability (Cronbach alpha = 0.63). The responses are given using a 4-point scale (0 - does not apply to me at all, to 3 - often or completely applies to me). The total result is the average of the assessments on the two statements, with a (reversed) high score indicating better adjustment.

Social component of SA included engagement in social and productive activities (ESPA). It was assessed by a list of 8 different categories of social and productive activities (e.g., helping friends and family members, attending cultural activities, religious activities, volunteering). We designed the list for the purpose of this study. Participants marked the activities in which they took part in the last 6 months. Since the scale showed a two-factor structure in the exploratory factor analysis, we used the total results for the two subscales. The first factor (ESPA1) refers to those activities in which older people had more opportunities to participate during the period of COVID-19 pandemic, when study was conducted (e.g. helping friends or family members, engaging in solitary hobbies or handicraft, attending religious activities). The second factor (ESPA2) refers to activities in which older people had probably less opportunity to participate during the COVID-19 pandemic (e.g. attending cultural activities, attending various educations, courses or public lectures, volunteering or participating in organized activities). Possible reasons for less participation were fear of infection, lack of interest or less opportunity for such activities to take place. The total result on each subscale was calculated as the sum of those categories of activities in which subjects participated during last 6 months period. Cronbach alpha coefficient for the whole scale obtained in this study was 0.60.

Subjective component primarily refers to the self- rating of one's own SA, either as an outcome assessed at one point in time, or as an ongoing process. Subjective SA was assessed via two questions asking participants to evaluate: (1) how successfully have they aged (SA as an outcome; SAO), and (2) how well are they aging (SA as a process; SAP; according to Pruchno et al., 2010). The responses are given on a scale from 0 (least successful) to 10 (most successful).

Procedure

The study was conducted within the research project Successful Aging: Development and Validation of an Integrative Multidimensional Model (IP.01.2021.21), funded by the University of Zadar, Croatia, as the second quantitative phase of the project. Participants were recruited using the snowball method, in different geographical regions of Croatia. Approximately 5% of the initially contacted persons refused to participate in the study. The questionnaires were administered individually in participants' homes by the authors or instructed researchers (project team members or MA psychology students). All participants gave informed consent for the participation in the study. The study was subject to the appropriate level of ethical review. It was approved by the Ethics Committee of University of Zadar (October 28, 2021, Decison Number: 114-06/21 − 01/22) and conducted from November, 2021 to February, 2022.

Data analysis

Before analysing the model of successful aging (SA), the latent structure of scales representing different factors of SA was tested. In order to evaluate which model of SA is best supported by the data, i.e., whether the proposed 5-factor model fits the data best, several models were tested via confirmatory factors analysis (CFA): (1) the proposed 5-component model with physiological/physical (CC, ADL, SRH), cognitive (CFQ-CL, CFQ-MEM), psychological/emotional (MH, SWLS, AAS), social (ESPA1, ESPA2), and subjective successful aging (SAO, SAP) component; (2) 4-component model including physical (CC, ADL, SRH), cognitive (CFQ-CL, CFQ-MEM), psychological/emotional and subjective (MH, SWLS, AAS, SAO, SAP), and social component (ESPA1, ESPA2); (3) 3-component model including physiological (CC, ADL, SRH), psychological (MH, SWLS, AAS, SAO, SAP, CFQ-CL, CFQ-MEM), and social component (ESPA1, ESPA2); (4) 2-component model including subjective (MH, SWLS, AAS, SAO, SAP, CFQ-CL, CFQ-MEM, SRH) and objective (CC, ADL, ESPA1, ESPA2) component. To scale factors, we used reference variable method. In each model, variable with the best psychometric characteristics, the largest number of discrimination units and better investigated in the literature was selected as the reference variable. Upon determining the best fitting first-order factor model, a model with a second-order factor representing the factor of SA was tested. The fit of the model was assessed using the following criteria: p value of the Chi square statistic >.05, CFI/TLI >.90, RMSEA <.08 (Hu & Bentler, 1999; Little, 2013). To compare models, a scaled chi square difference test was used (p <.05 non-acceptable; Satorra, 2000).

In order to test the stability of the structure of accepted model across age (young-old: 65–74 years; old-old: 75+) and gender (male; female), multigroup analyses were performed. We planned to test nested models that included: (1) an unconstrained model to test equality of factor structure across groups (configural invariance); (2) model with factor loadings constrained to be equal across groups (metric or weak invariance); (3) model with indicator intercepts/thresholds constrained to be equal across groups (scalar or strong invariance; Meredith, 1993). The nested models were compared based on the differences in Chi square test (p <.05 non-acceptable), CFI (≥ −.01 considered non-acceptable), and RMSEA (≥.015 considered non-acceptable; Putnick & Bornstein, 2016). The analyses were performed using IBM SPSS Statistics (Version 26) and psych (Revelle, 2020) and

lavaan (Rosseel, 2012) packages in R software (Version 4.0.2; R Core Team, 2020).

Results

Preliminary analysis

Before the main analysis, data were scanned for extreme collinearity (VIF > 5), univariate (|z| > 3.29) and multivariate outliers (Mahalanobis distance, p <.001), univariate (distribution inspection; Kolmogorov-Smirnov test, skewness, kurtosis, p <.001) and multivariate normality of distributions (Mardia's test, p <.001), and missing data (Tabachnick & Fidell, 2007). We found 48 univariate and 3 multivariate outliers. Although the outliers are, by the definition, an extreme part of the population, we decided to keep them because they represent either very successful or unsuccessful aging. In addition, data analysis with or without outliers showed similar results. Three values were missing and were excluded from further analysis. Kolmogorov-Smirnov test, kurtosis and skewness indicators, and distribution inspection indicated a univariate deviation from normality. Mardia's test indicate significant deviation from multivariate normality for skewness (2435.49, p <.001) and kurtosis (26.86, p <.001). Descriptive data are shown in Table 2.

Confirmatory factor analysis

Given that some indicators were ordinal items with four or five categories, CFA was performed using the robust weighted least squares (WLSMV) estimator.

Before analysing the SA model, we checked the factor structure of the scales that were used in the SA model as a total score on the whole scale or subscales. The latent analysis of the scales showed a satisfactory factor structure of the used scales (see Appendix).

The initial 5-component model with correlated latent factors and single indicators showed a good fit to data (Table 3). In the 1st step we compared the 5-component model with other 1st -order measurement models that include 2, 3 or 4 correlated components. Statistically significant differences were found for all models compared to the 5-component model, indicating the best fit to data for the 5-component model. Therefore, in the 2nd step we compared the 1st -order 5-component model including correlated components with the 2nd -order factor model including higher-order latent factor of successful aging. Although 2nd -order factor model showed an adequate fit to data, the 1st -order 5-component model had a statistically significant better fit. Therefore, the 1st -order 5-component model was accepted as the final model (Fig. 2). The model consisted of 5 latent

Table 2 Descriptive statistics and bivariate correlations for manifest variables used in models of successful aging (N = 767)

Variable	*M (SD)*	Range	1	2	3	4	5	6	7	8	9	10	11	12
1. CC	1.81 (1.32)	0–8	1											
2. ADL	51.81 (6.28)	17–56	–.33	1										
3. SRH	3.26 (0.78)	1–5	–.46	.42	1									
4. CFQ-CL	2.59 (2.44)	0–12	.24	–.27	–.21	1								
5. CFQ-MEM	8.91 (5.35)	0–32	.20	–.20	–.20	.59	1							
6. MH	66.48 (15.81)	4–100	–.21	.26	.43	–.29	–.36	1						
7. SWLS	4.92 (1.21)	1–7	–.22	.27	.38	–.25	–.20	.54	1					
8. AAS	1.76 (0.80)	0–3	–.26	.35	.41	–.26	–.24	.42	.39	1				
9. ESPA1	1.47 (0.95)	0–3	–.06	.28	.15	–.08	–.01	.44	.09	.16	1			
10. ESPA2	0.78 (1.17)	0–5	–.15	.21	.26	.01	–.04	.18	.16	.18	.25	1		
11. SAO	7.23 (1.80)	0–10	–.32	.23	.48	–.21	–.21	.42	.50	.36	.04	.16	1	
12. SAP	7.20 (1.84)	0–10	–.30	.24	.49	–.19	–.22	.43	.50	.39	.05	.19	.86	1

All correlation coefficients are significant at p < .01, except for the correlation between ESPA1 and CFQ-CL, SWLS (p < .05), correlation between ESPA1 and CC, CFQ-MEM, SAO, SAP (p > .05), and correlation between ESPA2 and CFQ subscales (p > .05)

CC Chronic conditions, *ADL* Activities of Daily Living Scale, *SRH* Self-rated Health, *CFQ-CL* Cognitive Failure Questionnaire– Clumsiness, *CFQ–MEM* Cognitive Failure Questionnaire–Memory, *MH* Mental Health subscale, *SWLS* Satisfaction with Life Scale, *AAS* Adjustment to Aging Scale, *ESPA1* Engagement in Social and Productive Activities subscale 1, *ESPA2* Engagement in Social and Productive Activities subscale 2, *SAO* Self-rated SA (outcome), *SAP* Self-rated SA (process)

Table 3 Fit indices of the successful aging model tested with the CFA ($N = 765$)

Model	χ^2	df	RMSEA	RMSEA 90% CI	CFI	TLI	$\Delta\chi^2(\Delta df)$
5- component	213.71	44	.071	.062,.081	.986	.979	
4- component	505.28	48	.112	.103,.121	.962	.948	55.66[b,a] (4)*
3- component	662.56	51	.125	.117,.134	.949	.934	174.11[c,a] (7)*
2- component	894.02	53	.144	.136,.152	.930	.913	200.51[d,a] (9)*
2nd -order	265.98	49	.076	.066,.084	.982	.976	28.94[e,a] (5)*

All χ^2, RMSEA and $\Delta\chi^2$ are significant at $p < .05$; *$p < .05$

[a]5-component model, [b]4-component model, [c]3-component model, [d]2-component model, [e]5-component model with 2nd-order latent factor of successful aging

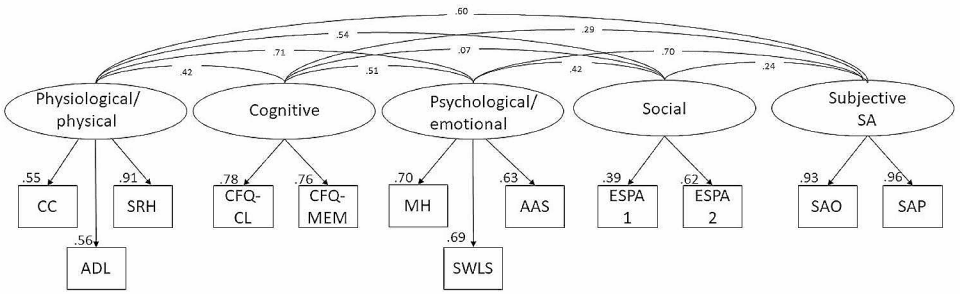

Fig. 2 CFA results of the accepted 5-factor model of SA. *Note.* CC = Chronic Conditions (reverse coding); ADL = Activities of Daily Living Scale, SRH = Self-rated Health, CFQ-CL = Cognitive Failure Questionnaire- Clumsiness (reverse coding), CFQ–MEM = Cognitive Failure Questionnaire– Memory (reverse coding), MH = Mental Health subscale, SWLS = Satisfaction with Life Scale, AAS = Adjustment to Aging Scale, ESPA1 = Engagement in Social and Productive Activities subscale 1, ESPA2 = Engagement in Social and Productive Activities subscale 2, SAO = Self-rated SA (outcome). SAP = Self-rated SA (process). All loadings and factor covariances are significant at $p < .01$, except nonsignificant covariance between Cognitive and Social factors

factors: physiological/physical (CC– reverse coded, ADL, SRH), cognitive (CFQ-CL, CFQ-MEM, both reverse coded), psychological/emotional (MH, SWLS, AAS), social (ESPA1, ESPA2), and subjective successful aging (SAO, SAP) factor. The correlations between physiological/physical and all other factors (cognitive– reverse coded, psychological/emotional, social, and subjective SA factor) were.42,.71,.54,.60, respectively. Cognitive factor (reverse coded) was positively related to both, psychological (.51) and subjective factor (.29). Psychological/emotional factor was also significantly corelated to both, social (.42) and subjective factor (.70), and subjective factor was related to social factor (.24). That is, higher results in any component of SA were positively associated with the results in other components. Only the relationship between cognitive and social factor was not statistically significant (.07, $p > .05$), indicating the mutual independence of these components.

Measurement invariance

Results of multigroup analyses (Table 4) showed that the factors were saturated with the same items in both gender groups and both age groups. That is, configural factorial invariance was found for age and gender subgroups. Moreover, full metric invariance was found for gender groups indicating equal loadings for both gender groups. Although full metric invariance was not confirmed for both age groups, partial metric invariance was found after allowing CC and SRH to be freely estimated across groups (X^2 (93) = 242.34, RMSEA =.065, CFI =.934; TLI =.907; ΔX^2 (5) = 6.68, $p > .05$). For younger group factor loadings were higher for both CC (.47) and SRH (.97) indicators compared to older age group (.27,.79 respectively).

Discussion

In this study, a 5-component model of SA was proposed, including physiological/physical, cognitive, psychological/emotional, social and subjective SA latent factors. The proposed model was compared with several other theoretical models that suggest 2, 3 or 4 components of SA. The results showed that the 5-component model fits data the best. The structure of the accepted model showed partial metric

Table 4 Comparison of SA structure models for young-old (65–74; $N = 454$) and old- old (75+, $N = 311$), and male ($N = 315$) and female ($N = 450$)

Age			Gender		
Parameters	Configural invariance	Metric invariance	Configural invariance	Metric invariance	Scalar invariance
X^2	251*	275.12*	248.44*	187.70*	262.24*
df	88	95	88	95	104
RMSEA	.070	.070	.069	.061	.063
CFI	.928	.921	.927	.939	.928
TLI	.892	.890	.890	.915	.908
Δdf		7		7	9
ΔX^2		22.86*		6.29[a]	35.59*
ΔRMSEA		.001		−.008	.002
ΔCFI		−.008		.012	−.011

*$p < .01$

[a]Scaled difference statistic proposed by Satorra and Bentler (2010) was used

invariance regarding age and metric invariance for different gender subgroups, i.e., all manifest variables (except CC and SRH in age groups) contribute to the latent constructs to a similar degree in analysed groups.

The results are partially in line with some previously proposed multidimensional models of SA, described in the introduction (e.g., Cosco et al., 2015; Kleineidam et al., 2019; Kok et al., 2017; Parslow et al., 2011; Pruchno et al., 2010; Vahia et al., 2012; Young et al., 2009). For example, model proposed by Young et al. (2009) includes three overlapping components– physiological, psychological, and social, but without cognitive and subjective SA as its distinct components. A 2-factor model by Pruchno et al. (2010) proposes a subjective and an objective component, which mainly tap into domains of physical functioning and subjective appraisal of success, but it does not mention other important domains, such as cognitive or social. An extended model of successful cognitive and emotional aging proposed by Vahia et al. (2012) is much closer to our proposed model; it added cognitive status, emotional status, and psychosocial factors to the model of SA. However, we believe that the proposed psychosocial protective factors (i.e., resilience, self-efficacy, optimism, and attitude toward own aging) should be regarded as determinants rather than components of SA. Further along, Kleineidam et al. (2019), suggest that a well-balanced operationalization of SA should include measures of physiological, well-being, and social engagement component, which is incorporated in our proposal.

We have included indicators of cognition and subjective SA as additional distinct components which were previously embedded within either the physiological (cognitive status), or psychological or well-being (subjective success) component. The model we propose resembles the one of *aging-well* (Fernandez-Ballesteros, 2019), which takes into consideration the biomedical dimension, with health and activities of daily living, physical function, and cognition, as well as psychosocial dimension, with good psychological adaptation and life engagement, and with both dimensions encompassing subjective and objective component. Although comprehensive, this model does not emphasize the subjective evaluation of one's aging process as a distinct component, which we believe is crucial for a good conceptualization and operationalization of SA.

When analysing and comparing models of SA with different number of components, we were guided by the different goodness-of-fit criteria (p-value of the chi-square statistic >.05, CFI/TLI >.90, RMSEA <.08; Hu & Bentler, 1999; Little, 2013) and the difference between the fit indicators (scaled chi square difference test with $p < .05$ not acceptable; Satorra, 2000). In the accepted 5-component model, those components that were defined as latent variables (physiological/physical, psychological/emotional, and subjective component) showed moderate to high intercorrelations, suggesting a common, i.e., higher order, factor of SA. The model with a 2nd -order factor of SA also showed adequate fit to the data. However, when compared to the 5-component model with correlated factors, a significant difference between models was found. The 5-component model showed better fit to data and was accepted as a final model. These results indicate there is no general factor of SA, but rather five separate components that are related due to the overlaps that exist between individual domains. One of the reasons for the poorer fit of the higher-order model compared to the 5-component model could be due to low correlations between latent factors that were represented by different scales (physiological/physical, psychological/emotional, subjective SA factors) and factors represented by subscales (cognitive and social factors), and the nonsignificant correlation between the cognitive and social factor.

The non-significant correlation between the cognitive and social factors might be indicative of a lack of convergent validity of the SA construct. However, the cognitive

and social factors represented by the subscales within the questionnaire better reflect the latent constructs measured by the CFQ and ESPA questionnaires - cognitive failures and involvement in social and productive activities. That is, it is possible that the cognitive and social factors did not capture different aspects of cognitive and social functioning. If the construct is not fully covered, this may affect the relationships of the latent variables. This is supported by studies that shows the positive relationship between general cognitive functioning and various aspects of social functioning (e.g. Kotwal et al., 2016; Krueger et al., 2009). Therefore, the inclusion of other measures of the same construct, such as the mental status or assessment of cognitive reserve for the cognitive component, and received social support, loneliness, quality of social relationships or other measures of social functioning for the social component, would allow clearer conclusion regarding the relationship of the latent variables. In this case it is possible that correlations between the components would be higher and the final accepted model might be a higher-order SA model. However, some SA components such as engagement in social and productive activities, or engagement in life (Rowe & Kahn, 1997), are quite broad and heterogeneous and, therefore, very challenging in terms of operationalization. For example, Young et al. (2009) believe that social component, among other factors, includes spirituality. However, since not a single older person interviewed in the qualitative phase of this project, has explicitly mentioned spirituality (or religiosity) as an important component or determinant of SA (Tucak Junaković & Ambrosi-Randić, 2022), it was not included in the proposed model. It is interesting to mention here that in the same qualitative phase of the study, longevity was rarely cited as a factor associated with SA, suggesting that people prefer quality of life over quantity, i.e. good over a very long life.

The accepted 5-component model showed full metric invariance for both gender groups, and partial metric invariance for younger and older age group. That is, for both male and female subgroups, all indicators contribute to each latent factor to the same degree. For two age groups, we found that all indicators, except CC and SRH, also similarly contribute to latent factors. That is, in older age, CC and SRH are both less related to physiological/physical factor compared to younger old age. This is in line with previous research that shows that in older age SRH is less influenced by physical health, and that other factors such as social factors (e.g. marital status, household size) influence SRH (Idler & Cartwright, 2018). It is also possible that in old age the number of chronic conditions makes a smaller contribution to health, as most older people have at least one chronic condition in old age. Perhaps the degree of disability due to illness or sensory impairment (e.g. impaired vision, hearing or ability to move) makes an important contribution to physical health in old age (Groessl et al., 2007). Also, different ways of dealing with chronic conditions, such as health behaviour and physical activity, may become more important determinants of physical health in older age (Langhammer et al., 2018).

In accordance with recent multidimensional models and a holistic approach to SA (Cosco et al., 2015; Kleineidam et al., 2019; Kok et al., 2017; Parslow et al., 2011; Pruchno et al., 2010; Urtamo et al., 2019; Vahia et al., 2012; Young et al., 2009), this study confirms SA as a multidimensional construct encompassing various components. The proposed 5-factor model is comprehensive because it includes all important components of the SA construct: (1) physiological/physical, (2) cognitive, (3) psychological/emotional, (4) social component and (5) subjective self-assessment of SA. Also, the model includes the objective, i.e., biomedical and physiological, as well as the subjective dimension of SA, which primarily refers to self-rated SA. As such, the model should contribute to better understanding of the complexity of the SA construct.

According to the proposed model, SA should be conceptualized as a continuum rather than a binary construct or outcome. The continuum perspective allows for an interdimensional variability at a specific point in time, as well as the intraindividual variability at different points of one's lifecycle. On the other hand, binary approach to SA, that categorizes people as either successful or unsuccessful, can conceal the heterogeneity of SA and aging population (Manierre, 2019). Similar to Young et al. (2009), we believe that people can compensate for decline in one domain (e.g., physiological) by functioning well in other domains (e.g., psychological or social). After all, research shows that even individuals with severely impaired health can consider themselves successful if they are satisfied with life and consider it meaningful (Kahana & Kahana, 2001; Young et al., 2009).

Limitations and future research directions

This study has several limitations which need to be underlined. The main limitation is the mentioned lack of a larger number of indicators that would allow defining the social and cognitive latent factor more extensively. Although cognitive failures are considered as a measure of everyday cognitive functioning (Carrigan & Barkus, 2016), the decision to use it for assessing cognitive component of SA could be seen as a potential shortcoming in terms of the operationalization of the cognitive status. Namely, CFQ does not always show a significant relation to objective measures of cognitive functioning (de Winter et al., 2015), and can

instead reflect negative emotional states, such as depression or anxiety (Sullivan & Payne, 2007). But we assumed that, compared to commonly used measures of cognitive status, such as the Mini-Mental State Examination (MMSE), CFQ will be a more discriminative indicator of cognitive status in this sample of older participants with, on average, good health and good objective cognitive status. On the other hand, MMSE is more appropriate for detecting cognitive impairment in cognitively heterogeneous samples of older people. However, using additional objective measures of cognitive functioning in CFA, such as mental status, memory, or reasoning tasks, would help to define the cognitive latent factor more profoundly. Similarly, using additional measures of social component, such as social support or loneliness, would enable a more extensive definition of the social latent factor. Larger number of indicators could contribute to a greater stability of cognitive and social latent factors thus strengthen the relationship between theoretically related components of SA.

Further potential limitation considers the inclusion of the component of subjective success as a distinct component of the proposed model. Questions on subjective success assess subjective SA directly, but other self-report measures (e.g., self-rated health, cognitive failures or life satisfaction) are also saturated with the subjective appraisal. Nevertheless, we believe that capturing subjective component as a distinct component of SA is a better solution then just partially imbedding the subjective dimension into other SA components.

When comparing different CFA models, different arrangements of measured variables were also possible (e.g., placing cognitive failures within the physiological component in the 3-factor model or shifting self-rated health within psychological component in the 3- and 4-factor models, etc.). This could affect the comparison between the models. An additional limitation refers to the shorter or newly constructed measures of poorer psychometric properties, which were used to operationalize some constructs (e.g., Adjustment to Aging Scale). This short measure was chosen to reduce the number of items in the questionnaire and to simplify its administration which is especially important in studies with older subjects.

Besides, it should be mentioned that this study was conducted during the COVID-19 pandemic, although in a period of a greater vaccination rate and less restrictions in everyday life. Nevertheless, older people were still less socially active compared to the pre-pandemic period (which they often pointed out themselves during the questionnaire administration). This could have affected the results on the measure of engagement in social and productive activities (ESPA). The ESPA had weaker psychometric characteristics compared to other used measures. This could have resulted in lower correlations with other latent factors. Therefore, future studies should consider using other measures when capturing social latent factor.

Since the study was conducted on a convenience sample of community-dwelling older people of relatively good health, functional status and subjective well-being, the possibility to generalize the obtained results to the other groups of older people, especially those living in institutional setting, is limited.

In future, we intend to determine the predictive contribution of sociodemographic characteristics, lifestyle factors (alcohol intake, physical activity, smoking habits, body mass index), and psychosocial factors (optimism, resilience, generativity, frequency of social contacts etc.) to SA conceptualized on the basis of the here proposed integrative multidimensional model. Furthermore, we intend to collect data on objective and subjective outcome criteria of SA at the future measurement point and to test the predictive validity of the model with respect to these outcomes. Objective measures we plan to use are mortality rate, health care and informal care utilization. Subjective psychosocial outcome would be sense of integrity, i.e., the ultimate meaning of life as the outcome of the last stage in the lifecycle, according to Erikson's psychosocial theory (Erikson & Erikson, 1998). It is very important to clearly distinguish between determinants or predictors, components, and outcomes or criteria of SA, which in earlier studies were often used interchangeably in turn leading to the conceptual confusion in SA research (Cosco, 2015; Pruchno et al., 2010). We tried to reduce this problem by offering a clearer conceptualization of SA components, which differ from the potential determinants and outcomes of SA. For example, constructs such as optimism or resilience are not treated as components of SA in this model, but as its determinants, while life satisfaction or mental health are treated as components rather than determinants or outcomes of SA.

Conclusion

Variability within definitions and measurements of SA burden the studies in the field (Katz & Calasanti, 2015), and call for a more universal description and operational definition of SA. Such endeavor needs to be empirically supported (Urtamo et al., 2019). We see the proposed multidimensional model of SA with its five components as a step towards achieving this ambitious goal, or at least as an attempt to develop a sound, comprehensive and generalizable multidimensional model of SA.

Appendix

Table 5 Fit indices of the scales used in successful aging model tested with the CFA ($N = 767$)

Variable	χ^2	df	RMSEA	RMSEA 90% CI	CFI	TLI
ADL (1-factor solution)	425.24	76	.078*	.070,.085	.984	.981
CFQ (2-factor solution)	344.41	52	.086*	.077,.094	.960	.950
MH (1-factor solution)	35.87	2	.149*	.108,.193	.993	.967
SWLS (1-factor solution)	94.17	5	.153*	.127,.180	.985	.970
ESPA (2-factor solution)	34.19	19	.032	.013,.049	.982	.974

All χ^2 are significant at $p < .01$.

ADL Activities of Daily Living Scale, *CFQ* Cognitive Failure Questionnaire, *MH* Mental Health subscale, *SWLS* Satisfaction with Life Scale, *ESPA* Engagement in Social and Productive Activities

*$p < .01$

Table 6 Standardized parameter estimates for the accepted model of each scale

Item	Scale loadings							Residual variance
	ADL	CFQ-CL	CFQ-MEM	MH	SWLS	ESPA2	ESPA1	
ADL1	.95							.11
ADL2	.91							.18
ADL3	.92							.15
ADL4	.94							.11
ADL5	.81							.34
ADL6	.87							.21
ADL7	.92							.15
ADL8	.96							.09
ADL9	.94							.11
ADL10	.78							.39
ADL11	.93							.14
ADL12	.79							.37
ADL13	.88							.23
ADL14	.87							.24
CFQ1		.58						.66
CFQ6		.79						.38
CFQ11		.85						.28
CFQ12		.66						.56
CFQ2			.60					.64
CFQ3			.70					.52
CFQ4			.72					.48
CFQ5			.71					.50
CFQ7			.80					.36
CFQ8			.74					.46
CFQ9			.77					.41
CFQ10			.77					.40
MH1				.44				.64
MH2				.61				.41
MH3				.87				.25
MH4				.63				.61
MH5				.81				.34
SWLS1					.82			.33
SWLS2					.85			.27
SWLS3					.81			.34
SWLS4					.75			.44
SWLS5					.73			.46
ESPA1						.49		.76
ESPA3						.71		.49
ESPA4						.81		.35
ESPA5						.90		.19
ESPA8						.73		.47
ESPA2							.62	.62
ESPA6							.52	.73
ESPA7							.27	.93

Residual covariance between ADL10 and ADL13 (stands for simple housework) equals 0.64; residual covariance between CFQ1 and CFQ2 (stands for traffic movement) equals 0.37; residual covariance between negatively worded items MH1, MH2 and MH4 ranged from 0.13 to 0.22

All parameters significant at $p < .01$

ADL Activities of Daily Living Scale, *SRH* Self-rated Health, *CFQ-CL* Cognitive Failure Questionnaire– Clumsiness, *CFQ–MEM* Cognitive Failure Questionnaire– Memory, *MH* Mental Health subscale, *SWLS* Satisfaction with Life Scale, *ESPA1* Engagement in Social and Productive Activities subscale 1, *ESPA2* Engagement in Social and Productive Activities subscale 2

Authors' contributions The study conception and design was made by Ivana Tucak Junaković. Material preparation and data collection were performed by Ivana Tucak Junaković, Marina Martinčević and Andrea Vranić. The analyses were performed by Marina Martinčević. The first draft of the manuscript was written by Ivana Tucak Junković and all authors commented on this version of the manuscript. All authors read and approved the final manuscript.

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Data availability The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of University of Zadar (Date: October 28, 2021/No: 114-06/21-01/22).

Consent to participate Written informed consent was obtained from all individual participants included in the study.

Competing interests The authors have no relevant financial or non-financial interests to disclose.

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