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Socio-demographic factors associated with changes in successful aging in Spain: a follow-up study

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Abstract

Objectives

Successful aging (SA) refers to maintaining wellbeing in old age. Several definitions or models of SA exist (biomedical, psychosocial and mixed). We examined the longitudinal association between various SA models and socio-demographic factors, and analyzed the patterns of change within these models.

Methods

This was a nationally-representative follow-up in Spain including 3,625 individuals aged ≥50 years. Some 1,970 were interviewed after three years. Linear regression models were used to analyze the survey data.

Results

Age, sex and occupation predicted SA in the biomedical model, while marital status, educational level and urbanicity predicted SA in the psychosocial model. The remaining models included different sets of these predictors as significant. In the psychosocial model, individuals tended to improve over time but this was not the case in the biomedical model.

Conclusions

The biomedical and psychosocial components of SA need to be addressed specifically to achieve the best aging trajectories.

Introduction

The growing number of people in older age groups in Spain is a matter of public health concern. According to the Spanish National Statistics Institute, 24.1% of the Spanish population was 60 years old or over in 2016 (Instituto Nacional de Estadística, 2017). This percentage is projected to rise to 33.5% (11 million people) by 2030, according to the United Nations. This percentage of older adults in Spain by 2030 is higher than the average figure for Europe (29.6%) and especially Eastern Europe (25.7%) (United Nations, 2015).

The United Nations describes current population aging as a widespread phenomenon with unprecedented and profound implications for many facets of human life. The pace of demographic change differs greatly across regions, and countries that tackle this trend later will have less time to adapt. Responding to the needs of an increasingly aging population has been identified by the European Commission as one of the political challenges of the XXI century (European Commission, 2006) and has led to an increase in scientific research into the aging process. A number of studies propose an alternative view to the pessimistic, traditional perspective on aging as unavoidable, progressive disengagement from an active life (Cumming & Henry, 1961). These more optimistic studies foster a view of elderly individuals as active agents in society.

One of the most commonly used terms to refer to the notion of "aging well" in scientific literature has been successful aging (SA). Rowe and Khan first operationalized three criteria for SA: freedom from disease and disability; high cognitive and physical functioning; and productive engagement (Rowe & Khan, 1998). Since then, several other SA models have been proposed with three general definitions: biomedical; psychosocial; and combinations of the two (bio-psychosocial)

(Bowling & Dieppe, 2005). The distinct SA models can be assessed using either self-rated or researcher-measured indicators (Gu et al., 2016). The variety of definitions and indicators make the comparison of SA prevalence rates among studies difficult, with figures ranging from 0.5% to 95% (Depp & Jeste, 2006).

In a recent systematic review, five broad SA-component categories were proposed: physiological status (physical and mental health); commitment (social participation); well-being (satisfaction with life); personal resources (resilience and autonomy); and external factors (socio-economic indicators) (Cosco et al., 2013a). Physiological status and personal resources are related to biomedical models whereas commitment and well-being have a psychosocial nature. Our previous study used these categories to design a complete model that encompasses all five broad SA-component categories (Perales et al., 2014).

Those studies, comparing biomedical and psychosocial (Depp & Jeste, 2006) or researcher-defined and respondent-rated SA models (Gu et al., 2016) have shown that the correlates of one model are poor predictors of others. The aim of this study was to examine the longitudinal association between various SA models and socio-demographic factors. We also aimed to analyze the patterns of change in SA over time using these different models.

-Insert Table 1 about here-

Methods

Study design

This study was part of the Collaborative Research on Aging in Europe (COURAGE in Europe) project (Leonardi et al., 2014), a longitudinal survey of the

non-institutionalized adult population (aged ≥18 years). In Spain, the first wave was conducted between July, 2011 and May, 2012 and the second wave between December, 2014 and June, 2015.

A total of 4,753 participants were initially interviewed: 962 aged 18–49, 3,312 aged 50–79 and 479 aged 80 and over. In order to achieve appropriate representation of the Spanish population, a stratified multistage clustered area probability method was used. Age cohorts 50-79 and 80 and over were oversampled, given that these individuals were the main study target. The individual response rate was 69.9% at baseline and 69.5% during follow-up.

Face-to-face structured interviews were carried out at respondents' homes using Computer-Assisted Personal Interviewing (CAPI). The survey questionnaire was initially developed in English and then translated into Spanish following World Health Organization translation guidelines for assessment instruments (Üstun et al., 2005). Quality assurance procedures were implemented during fieldwork. During wave 1, participants with severe cognitive impairment, judged at the interviewer´s discretion or based on a previous diagnosis of dementia, were not interviewed and a shorter version of the questionnaire was administered to proxy respondents. At the beginning of the second interview, some 3 years later, a second cognitive screening questionnaire was used to assess any changes in patients' cognitive abilities (Lobo et al., 1979).

For the current analyses, we excluded 958 individuals aged <50 years and 170 proxy respondents from the first wave, leaving a sample of 3,625 individuals eligible for our study. Of these, for Wave 2, 4.86% had died, 25.49% refused further visits, 4.28% could not be located, and 11.03% could not be contacted for some other reason. Furthermore, 84 (4.26%) proxy individuals from wave 2 were excluded as

information on main variables was not available. Therefore, the final study sample consisted of 1,886 participants. Sampling weights were generated to compensate for the survey design and non-response in the follow-up assessment, so that the results were representative of the Spanish population (Moussavi et al., 2007).

Ethics statement

Ethical approval for the COURAGE study Spain was provided by Parc Sanitari Sant Joan de Déu, Barcelona, Spain, and Hospital la Princesa, Madrid, Spain. Written informed consent was obtained from all participants in both waves.

-Insert Table 2 about here-

Measurements

Socio-demographic characteristics

Participants were asked to provide socio-demographic data on age, sex, level of education, marital status, occupation and urbanicity. Education was categorized as incomplete primary school, primary school, lower secondary school, upper secondary school, and "college/university". Information on marital status was classified as follows: never married, currently married, cohabiting, separated/divorced, and widowed. ISCO 08 categories were used to define occupation (European Union, 2009). ISCO 08 classification contains nine main groups which were classified into 3 skills: elementary occupations as skill level 1, occupations between plant/machine operators and assemblers/clerical support workers as skill level 2, and technicians and associate professionals, professionals and managers as skill level 3.

Biomedical variables

Chronic medical conditions were assessed based on self-report diagnoses of chronic lung disease, asthma, hypertension, arthritis, stroke, angina, and diabetes in the previous 12 months. Additionally, a symptom algorithm was used to detect non-diagnosed cases of arthritis, stroke, angina, chronic lung disease, and asthma (Garin et al., 2016).

The 12-item interviewer-administered version of the World Health Organization Disability Assessment Schedule version II (WHODAS-II) (World Health Organization, 2012) was used to assess disability. Participants were asked to report the level of difficulty they had in performing various activities such as dressing or concentrating during the previous 30 days using a five-point scale (none = 1, mild = 2, moderate = 3, severe = 4, and extreme/cannot do = 5). The total score ranges from 0 to 100 with higher scores indicating greater disability.

An adapted version of the Composite International Diagnostic Interview (CIDI 3.0) was used to assess the presence of depression in the previous 12 months (Haro et al., 2006). An algorithm based on the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders was used (American Psychiatric Association, 1994). Cognitive functioning was assessed using five performance tests measuring three domains: learning and short-term memory, working memory and verbal fluency. A composite of these five scores was calculated (He et al., 2012). The total score ranges from 0 to 100 with higher scores indicating better cognition.

Tobacco consumption was assessed by asking whether participants were daily smokers, non-daily smokers, former smokers, or had never smoked. Alcohol consumption was assessed by asking whether participants were lifetime abstainers, and if not, the pattern of alcohol consumption in the previous week. They were then classified as lifetime abstainers; occasional drinkers (no consumption in previous 7

days); non-heavy drinkers (consumed alcohol in previous 7 days); and heavy drinkers (consumed alcohol >1-2 days per week, with 5 or more standard drinks in past 7 days for men and 4 or more for women).

Physical activity was measured using the Global Physical Activity Questionnaire (Armstrong & Bull, 2006), which collects information on physical activity in three settings as well as sedentary behavior, consisting of 16 questions about activity at work, travel to and from places, and recreational activities.

Psychosocial variables

Social participation was measured using 11, five-point Likert-scale questions ranging from never to daily on how often in the previous 12 months the person had participated in activities such as attending public meetings or meeting community leaders. Social contacts were measured using 10, five-point Likert scale questions ranging from never to daily on how often in the previous 12 months the person had had contact with other people such as their partner, children, or neighbors.

Social support was measured using the Oslo social support scale (Bøen et al., 2012). This scale consists of three items: "How many people are you so close to that you can count on them if you have great personal problems? [from none (1) to more than five (4)]," "How much interest and concern do people show in what you do? [from a lot (1) to none (5)]," and "How easy is it to get practical help from neighbors if you should need it? [from very easy (1) to very difficult (5)]."

Self-rated quality of life was measured with a single five-point Likert scale question with responses on a range from very good to very bad. Control and coping were measured using a five-point Likert scale question with responses ranging from never to very often on how frequently in the previous two weeks the participants had

been unable to control important things in their lives and to cope with things they had to do.

External variables

Environmental safety was measured through two items asking: "In general, how safe from crime and violence do you feel at home?" and 'How safe do you feel when walking down your street (neighborhood) alone after dark?" ranging from completely safe to not safe at all on a five-point Likert scale. Respondents were asked for their best estimates of total household income, including income from wages or stipends from a job as well as income from unemployment benefit, pensions, investments, aid to families or other government or non-government benefits during the previous 12 months.

SA models

The indicators used for the construction of the distinct SA models were selected on the basis of previous literature (Cosco et al., 2014; 2013a; 2013b) and their operationalization has previously been reported (Perales et al., 2014). Specifically, the following models and indicators were considered: i) biomedical, requiring no presence of any chronic medical conditions, a score below the median on the WHODAS-II (i.e., from 0 to 3), a value equal to or above the median in the cognition composite score (i.e., from 51 to 100), no presence of depression in the previous 12 months, not being a current smoker, being an occasional drinker or lifetime abstainer and being engaged in moderate or high physical activity; ii) psychosocial, requiring engagement in three or more separate social activities at least once a month, having three or more social contacts with at least one month of frequency, a score ranging from 12 to 14 on the Oslo social support scale, good or very good self-reported quality of life, never or almost never unable to control

important things in life, and never or almost never unable to cope with things they have to do; iii) Rowe and Khan's definition of SA (Rowe & Khan, 1998), which requires no presence of chronic medical conditions, a score below the median on the WHODAS-II, a value equal to or above the median in the cognition composite standardized total score by education, no presence of depression in the previous 12 months, and being engaged in three or more different social participation activities at least once a month; iv) a complete model of SA that included all those indicators and external components (household income equal to or above the median and very or completely safe in both items: at home and on the street). These models were operational zed as the sum of the different indicators assigning one point to each one. In all cases higher scores indicate better SA.

Statistical methods

Stata software (version SE 12) was used to analyze the survey data. Descriptive analyses were conducted to characterize the study sample in both waves. These analyses included weighted proportions, unweighted frequencies, means and standard deviations. Differences between means of the complete SA model in categories of socio-demographic variables at baseline and follow-up were tested through Student´s t-tests and ANOVA. We also tested these SA means by comparing individuals who had completed the follow-up interview with those who had not according to each of the specific reasons given.

We fitted linear regression models to evaluate which baseline socio-demographic factor predicted the SA change from baseline to follow-up for each model. The level of statistical significance for all analyses was set at 0.05. Beta coefficients, 95% confidence intervals, adjusted R 2 and p values were reported in each model.

Stability of SA was analyzed by calculating the intraclass correlation coefficient (ICC) between baseline and follow-up. Additionally, the proportion of individuals that improved, got worse or remained stable were plotted for each SA model. According to Cicchetti, the average correlation is poor from 0 to 0.39, fair from 0.40 to 0.59, good from 0.60 to 0.74 and excellent from 0.75 to 100. (Cicchetti, 1994).

-Insert Table 3 about here-

Results

Table 1 summarizes the socio-demographic characteristics of the participants at baseline and follow-up with mean SA scores for each category using the complete model. The means of SA scores were higher at the follow-up than at the baseline (8.6 vs. 8.9). Significantly higher SA scores were also found in men, younger individuals, participants with a higher level of education and occupation, and those who were married or cohabiting.

Table 2 shows complete model SA score means at baseline stratified by participation and reasons for not participating at the follow-up. Individuals who were in an institution, deceased or did not sign the informed consent form at follow-up assessment had significantly lower SA scores than those in the longitudinal data (6.6, 7.5, 8.2 vs. 8.7; $p<0.001$).

Table 3 shows linear associations between socio-demographic factors at baseline and SA at follow-up adjusted for SA at baseline using distinct SA definitions. Men had significantly higher scores on the psychosocial model and women had higher scores on the biomedical. Age was inversely associated with all SA models except the psychosocial. There was an education gradient, with those with a lower level of

education showing lower SA scores than those with higher education. A similar gradient was found for occupation, although individuals who had never worked did not show statistically significant lower SA scores. The gradients were least marked in the biomedical model. Widows had lower SA scores than participants who were married or cohabiting across all models. People living in urban areas scored higher on SA in the psychosocial model.

After adjusting for all covariates simultaneously, multivariate analyses confirmed the base case model results with some exceptions (Table 4). Principally, men no longer had higher scores than women in the psychosocial model. The education gradient was not as evident and was only significant in the Rowe & Khan and psychosocial models. Those with skill level 3 in occupation scored higher in SA compared with skill level 1, except for the psychosocial model in which it did not reach significance.

Figure 1 shows SA score stability between wave 1 and wave 2. In both the psychosocial and complete models, more individuals improved their SA level from baseline to follow-up than in the Rowe and Khan and biomedical models, in which there were more individuals worsening. Figure 1 also shows the ICC. The average correlation within individuals was poor for the psychosocial model (0.37) and fair for remaining SA models (range=0.44-0.51). On the other hand, the average correlation within model was fair for the psychosocial model (0.54) and good for remaining SA models (range=0.61-0.67).

-Insert Table 4 about here-

Discussion

This study examined the longitudinal association between socio-demographic factors and SA and how they vary depending on the SA model considered. Our results reveal that while socio-demographic characteristics such as marital status, urbanicity and education are the most relevant SA predictors when conceptualized using a psychosocial model, aspects such as age, sex and occupation are the main determinants for the biomedical SA model. In contrast, both the complete and Rowe & Khan models, which include biomedical and psychosocial components, showed mixed results. To sum up, socio-demographic predictors of biomedical SA are associated with health risk factors such as male gender or precarious work, while predictors of psychosocial SA are factors associated with social networks, such as level of education and marital status. Therefore, both SA components should be addressed as complementary.

In surprising contrast to the other models, older age was not associated with worse SA when using a psychosocial model. This is in line with the cross-sectional results obtained by Perales et al. (2014). The lack of association with age is consistent with the idea that older people can do as well or sometimes even better than young people with regard to happiness or the management of social relations (Carstensen, 2006). These findings are also consistent with previous cross-sectional research in older adults living in various communities in San Diego, CA, that used a definition of SA including more psychosocial than biomedical components (Montross et al., 2006).

Other studies also reinforce the evidence on the absence of a relationship between age and SA: a longitudinal study of a representative sample of older adults living in Manitoba (Canada) showed that, while older age was a predictor for cognitive or physical problems and mortality, it did not predict happiness or life

satisfaction (Menec, 2003). However, a review conducted by Depp and Jeste (2006) including several studies, such as the two above-mentioned studies, found that age was a significant predictor of SA, although these studies used SA models with a high proportion of biomedical components such as physical activities (Strawbridge et al., 1996) or chronic diseases (Burke et al., 2001).

We found that the relationship between sex and psychosocial SA was strongly linked to marital status. Linear regression adjusted for SA model at baseline showed that being female is a predictor of lower levels of psychosocial SA compared with men. However, this relationship disappeared when adjusting for marital status. In our sample, most separated or divorced individuals were women (9.0% vs. 4.8%, $p<0.001$). Additionally, the harmful effects of being single on SA are stronger for men. A cross-sectional community survey of individuals aged 50 years and older in 15 European countries also found that unmarried individuals showed lower levels of psychosocial well-being but that never married and divorced women exhibited higher odds of participation in social activities than men (Trevisan et al., 2016). Studies also demonstrate that frailty also seems to be higher among unmarried men than women (Finkel et al., 2016). In addition, we found a significantly lower level of biomedical SA for men, which could be explained by differences in life-style risk factor exposure between genders (inadequate diet, physical inactivity, and excessive alcohol and tobacco use) (Varì et al., 2016). There are also specific gender differences in cardiovascular risks related to estrogens being a protector for women and abdominal obesity being more prevalent in males (Harvard Men's Health Watch, 2010).

Education and occupation, both common indicators of socio-economic status, showed different relationships with SA depending on the model applied. In the base case model, higher levels of occupation and education were found to be predictors of

higher levels of SA in all models but when both are included in a multivariate model, education was a predictor only in the psychosocial and Rowe & Khan SA models, while occupation was not a predictor in the psychosocial model. Having a higher educational level provides relational and intellectual resources throughout life and it is associated with a greater sense of control and hope, and protects against age-associated declines in psychosocial functioning (Mitchell, el al., 2016). A higher educational level is a significant SA predictor in models with psychosocial components such as subjective life satisfaction (Menec, 2003) or objective social support (Vaillant & Mukamal, 2001). However, the effect of occupation may be due to other mechanisms. The relationship between occupation and the biomedical SA model might be attributed to the widely-recognized harmful effects of precarious work (particularly high in Spain compared with other European countries) on physical and mental health. Moreover, a lower socio-economic position may be related to fewer resources to cope with the presence of diseases, and with living in more deprived and unsafe environments (Lynch, 2000). Finally, urbanicity was also found to be a predictor of psychosocial SA. Studies on SA have not taken this factor into account even though rural aging is a specific matter of study related to mental and physical well-being (Burholt & Dobbs, 2012).

Our findings have shown that urbanicity, along with education and marital status are predictors of psychosocial SA. These factors are commonly associated with qualitative aspects of social life among the elderly such as social isolation or loneliness (Community Development Halton, 2016). These associations are also in line with the social capital theory which conceptualizes subjective well-being as being predicted by the breadth and depth of social connections. Individuals with close friends and confidants, neighbors, friends and co-workers support are less likely to

experience sadness, loneliness and low self-esteem (Helliwell & Putnam, 2004). Therefore, variables that directly influence the social network are associated with better psychosocial SA.

Strengths and limitations of the study

The strengths of this study include the use of a large community-representative sample with older adults from a variety of socio-economic backgrounds, the option of including several covariates, and the longitudinal design which enables us to examine causal relationships. However, we need to consider a number of limitations associated with these findings. First, about one fourth of the individuals declined to be evaluated at follow-up. This could potentially bias the results since these people may have had different SA patterns to those evaluated. Second, comparability across studies is difficult given the measurement inconsistencies among them. Third, since the present study did not have identical aims to the COURAGE in Europe project, some SA aspects (i.e., environmental fit, personal growth, etc.) were not included as part of the questionnaire. However, we did include a number of variables that are representative of the major SA components, namely biomedical, psychosocial, and external factors. Fourth, we did not include dying in our definitions of SA, which is an important factor to take into account (Cosco et al., 2013), because it is incompatible with consideration of SA as a continuous variable. Finally, some of the variables were collected retrospectively through self-report, which may result in recall or reporting bias. Nevertheless, most epidemiological studies have used self-reported data, and recall biases are usually relatively minor (Kriegsman, et al., 1996).

-Insert Figure 1 about here-

Conclusions

The results of this study suggest that biomedical and psychosocial components of SA should be addressed differently given their different associations with socio-demographic factors. Results also suggest that addressing psychosocial components could lead to large SA improvements. Although several researchers have underlined the need to create social environments that foster aging well in the EU, there is a clear tendency to reduce the costs of aging by extending working life, along with a lack of integrated social policies (Foster & Walker, 2015).

We hope that this study contributes to raising awareness of the need for more longitudinal studies of SA determinants, complemented with qualitative studies which may help to achieve a better understanding of the associations found here. Based on our findings, to overcome the limits of each approach, a double theoretic strategy is encouraged: (1) As a precondition for a broad understanding of successful aging it is necessary to establish consensus in the scientific community on the main biomedical and psychological factors, and (2) a comprehensive interdisciplinary inquiry into the role of social structures (social networks and social classes) in successful aging is needed.

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Declaration of Conflicting Interests

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

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Table 1. Socio-demographic characteristics of the participants at baseline and follow-up, and mean scores (0-15) of SA using the complete model.

	Baseline n (%)	SA (BL) Mean (SD)	*p* value [a]	Follow up n (%)	SA (FU) Mean (SD)	*p* value [a]
Sample size	3625 (100.0)	8.6 (2.3)	-	1886 (100.0)	8.9 (2.1)	-
Sex						
Women	1982 (53.7)	8.5 (2.3)	<0.001	1009 (51.6)	8.7 (2.2)	0.005
Men	1643 (46.3)	8.8 (2.2)		877 (48.4)	9.0 (2.0)	
Age						
50-59 years	1206 (32.2)	8.9 (2.3)	<0.001	702 (36.6)	9.2 (2.1)	<0.001
60-69 years	1041 (28.2)	8.8 (2.2)		562 (29.2)	9.1 (2.1)	
70-79 years	999 (29.3)	8.4 (2.3)		477 (26.7)	8.4 (2.1)	
80+ years	379 (10.3)	7.8 (2.1)		145 (7.5)	8.0 (2.0)	
Highest education level						
College / University	393 (10.8)	9.6 (2.2)	<0.001	233 (12.4)	9.8 (1.9)	<0.001
Upper secondary school	541 (14.5)	9.2 (2.1)		289 (15.1)	9.4 (2.0)	
Lower secondary school	408 (11.1)	8.7 (2.2)		209 (10.7)	9.0 (2.0)	
Primary school	1075 (31.3)	8.7 (2.2)		566 (31.1)	8.9 (2.0)	
Incomplete primary school [b]	1207 (32.3)	8.0 (2.2)		589 (30.7)	8.2 (2.2)	
Occupation [c]						
Skill level 1	541 (16.7)	8.2 (2.2)	<0.001	273 (15.7)	8.5 (2.1)	<0.001
Skill level 2	1559 (48.8)	8.7 (2.2)		815 (49.5)	8.8 (2.1)	
Skill level 3	680 (19.9)	9.2 (2.3)		381 (21.7)	9.6 (2.0)	
Never worked	497 (14.6)	8.3 (2.2)		248 (13.1)	8.5 (2.1)	
Marital status						
Never Married	310 (8.5)	8.6 (2.3)	<0.001	168 (9.2)	8.9 (2.1)	<0.001
Currently married	2189 (60.6)	8.8 (2.2)		1202 (65.3)	9.1 (2.0)	
Cohabiting	69 (1.8)	8.5 (2.1)		30 (1.7)	9.3 (1.4)	
Separated / divorced	266 (7.0)	8.3(2.3)		139 (6.6)	8.4 (2.3)	
Widowed	791 (22.1)	8.1 (2.4)		347 (17.2)	8.3 (2.2)	
Urbanicity						
Rural	487 (16.2)	8.5 (2.2)	0.150	269 (17.3)	8.7 (2.2)	0.088
Urban	3138 (83.8)	8.6 (2.3)		1617 (82.7)	8.9 (2.1)	

Unweighted frequencies (n), and weighted proportions are displayed, or as otherwise indicated.

[a] Student´s t-tests and ANOVA tests were carried out to compare means of SA among categories.

[b] Include no formal education received.

[c] ISCO 08 categories were grouped into three levels according to their skill level. Skill level 1 corresponds to elementary occupations. Skill level 2 corresponds to occupations between plant and machine operators, and assemblers and clericals support workers. Skill level 3 corresponds to technicians and associate professionals, professionals, and managers.

Abbreviations: SA=Successful Aging; SD=Standard deviation; BL=Baseline; FU=Follow-up; n=frequency.

Table 2. Comparison of baseline SA scores among participants who participated at follow-up and those who did not using the complete SA model

	SA (BL) [a] Mean (SD)	*p* value [c]
Completed interview	8.7 (2.2)	-
Final refusal by a family member	8.8 (2.1)	0.553
Unable to locate household or individual	9.2 (2.3)	0.015
House is vacant or different household occupants	8.6 (2.3)	0.703
Deceased	7.5 (2.2)	>0.001
Individual respondent in an institution	6.6 (2.4)	>0.001
Final refusal by individual respondent	8.7 (2.3)	0.888
Did not sign the informed consent for follow-up	8.2 (2.4)	>0.001
Other[b]	8.4 (2.2)	0.321

[a] Complete model of SA at baseline. Higher scores indicate more SA.
[b] "Other" includes partial interviews or no interview because individual respondent was not eligible, language barrier, unsafe or dangerous area or address that did not exist.
[c] Student´s t-tests were carried out to compare means of active aging between completed interview and the remaining categories.
Abbreviations: SA=Successful Aging; BL=Baseline; SD=Standard deviation.

Table 3. Linear regression models showing associations between socio-demographic variables at baseline and SA at follow-up adjusted for SA at baseline using different SA models.

	Rowe & Khan's model rating (0-5) at follow up [a] β (95% CI)	**Biomedical model rating (0-7) at follow up** [a] β (95% CI)	**Psychosocial model rating (0-6) at follow up** [a] β (95% CI)	**Complete model rating (0-15) at follow up** [a] β (95% CI)
Sex				
Women	Ref.	Ref.	Ref.	Ref.
Men	0.01 (-0.09, 0.10)	-0.18** (-0.31, -0.05)	0.19** (0.06, 0.33)	0.19 (-0.04, 0.43)
Age (in years)	-0.03*** (-0.03, -0.02)	-0.02*** (-0.03, -0.01)	-0.00 (-0.01, 0.00)	-0.03*** (-0.04, -0.02)
Highest education level				
College / University	Ref.	Ref.	Ref.	Ref.
Upper secondary school	-0.03 (-0.21, 0.15)	0.01 (-0.24, 0.25)	-0.10 (-0.40, 0.20)	-0.20 (-0.56, 0.15)
Lower secondary school	-0.24* (-0.44, -0.03)	-0.03 (-0.27, 0.21)	-0.25* (-0.46, -0.04)	-0.40* (-0.77, -0.03)
Primary school	-0.30** (-0.50, -0.10)	-0.13 (-0.34, 0.08)	-0.21 (-0.46, 0.04)	-0.43* (-0.77, -0.09)
Incomplete primary school [b]	-0.59*** (-0.80, -0.39)	-0.28* (-0.51, -0.06)	-0.59*** (-0.83, -0.34)	-0.96*** (-1.33, -0.59)
Occupation				
Skill level 1	Ref.	Ref.	Ref.	Ref.
Skill level 2	0.23** (0.09, 0.38)	0.11 (-0.07, 0.28)	0.20* (0.01, 0.39)	0.28* (0.01, 0.55)
Skill level 3	0.41*** (0.22, 0.59)	0.25* (0.06, 0.44)	0.43** (0.18, 0.67)	0.77*** (0.44, 1.09)
Never worked	-0.07 (-0.25, 0.11)	0.00 (-0.20, 0.20)	0.10 (-0.12, 0.31)	0.10 (-0.20, 0.40)
Marital status				
Married or cohabiting	Ref.	Ref.	Ref.	Ref.
Widowed	-0.23** (-0.36, -0.10)	-0.16* (-0.30, -0.02)	-0.23** (-0.40, -0.06)	-0.63*** (-0.89, -0.36)
Separated / divorced	0.01 (-0.18, 0.21)	0.11 (-0.14, 0.35)	-0.29 (-0.64, 0.06)	-0.35 (-0.79, 0.08)
Never married	0.06 (-0.14, 0.26)	0.13 (-0.06, 0.32)	-0.09 (-0.34, 0.15)	-0.02 (-0.43, 0.39)
Urbanicity				
Rural	Ref.	Ref.	Ref.	Ref.
Urban	0.00 (-0.15, 0.15)	-0.18 (-0.38, 0.02)	0.35** (0.11, 0.60)	0.04 (-0.38, 0.46)

Abbreviations: Ref.=Reference category; SA= Successful Aging; β=Beta coefficient; CI=Confidence Interval.

[a] Higher scores indicate more SA.

[b] Include no formal education received.

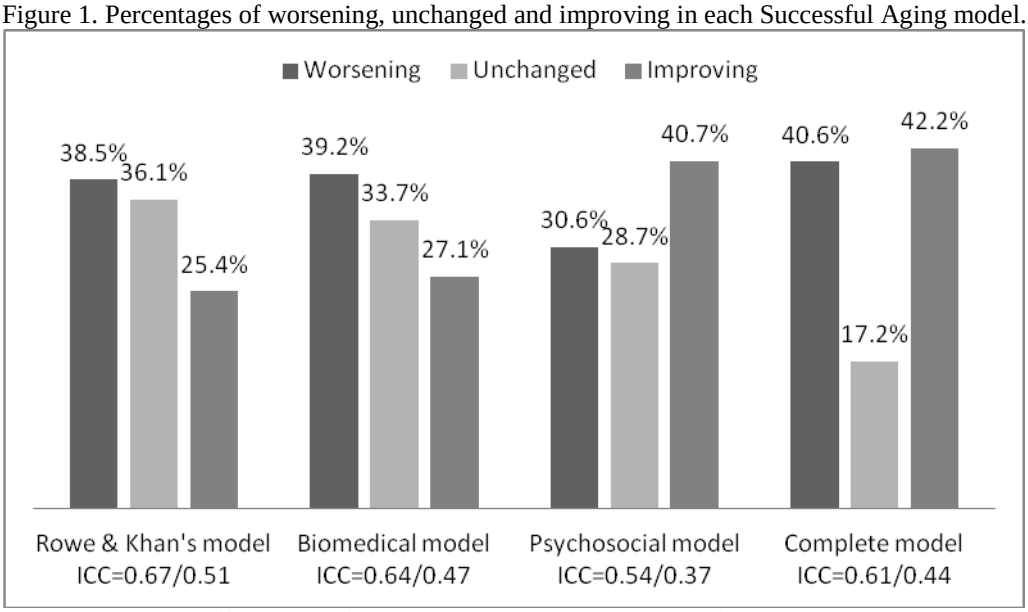
*p<0.05, **p<0.01, ***p<0.001.

Table 4. Multivariate linear regression models showing associations between socio-demographic variables and SA at baseline and SA at follow-up using different SA models.

	Rowe & Khan's model rating (0-5) at follow-up [a] β (95% CI)	**Biomedical model rating (0-7) at follow-up** [a] β (95% CI)	**Psychosocial model rating (0-6) at follow-up** [a] β (95% CI)	**Complete model rating (0-15) at follow-up** [a] β (95% CI)
Intercept	2.63 (2.16, 3.11)	3.31 (2.64, 3.98)	2.72 (2.04, 3.40)	7.44 (6.32, 8.55)
Sex				
Women	Ref.	Ref.	Ref.	Ref.
Men	-0.05 (-0.16, 0.06)	-0.25** (-0.38, -0.11)	0.12 (-0.03, 0.27)	0.03 (-0.27, 0.34)
Age (in years)	-0.02*** (-0.03, -0.02)	-0.02*** (-0.03, -0.01)	0.00 (-0.01, 0.01)	-0.03*** (-0.04, -0.01)
Highest education level				
College / University	Ref.	Ref.	Ref.	Ref.
Upper secondary school	-0.08 (-0.27, 0.11)	-0.05 (-0.33, 0.22)	-0.10 (-0.43, 0.24)	-0.16 (-0.55, 0.22)
Lower secondary school	-0.23* (-0.45, -0.01)	-0.02 (-0.27, 0.23)	-0.27* (-0.53, -0.02)	-0.41 (-0.84, 0.03)
Primary school	-0.24* (-0.44, -0.04)	-0.69 (-0.31, 0.17)	-0.19 (-0.47, 0.09)	-0.25 (-0.72, 0.22)
Incomplete primary school [b]	-0.38*** (-0.59, -0.17)	-0.08 (-0.35, 0.20)	-0.54*** (-0.82, -0.25)	-0.52 (-1.07, 0.03)
Occupation				
Skill level 1	Ref.	Ref.	Ref.	Ref.
Skill level 2	0.20** (0.06, 0.34)	0.15 (-0.01, 0.31)	0.08 (-0.12, 0.27)	0.16 (-0.12, 0.45)
Skill level 3	0.22* (0.05, 0.39)	0.23* (0.02, 0.45)	0.15 (-0.11, 0.41)	0.45* (0.03, 0.87)
Never worked	0.04 (-0.15, 0.23)	0.06 (-0.14, 0.26)	0.15 (-0.07, 0.37)	0.32* (0.00, 0.65)
Marital status				
Married or cohabiting	Ref.	Ref.	Ref.	Ref.
Widowed	0.03 (-0.11, 0.16)	-0.02 (-0.18, 0.14)	-0.14 (-0.34, 0.07)	-0.28 (-0.58, 0.02)
Separated / divorced	-0.05 (-0.25, 0.14)	0.07 (-0.16, 0.31)	-0.39* (-0.74, -0.03)	-0.48* (-0.90, -0.06)
Never married	0.01 (-0.17, 0.18)	0.10 (-0.08, 0.28)	-0.09 (-0.33, 0.15)	-0.06 (-0.48, 0.35)
Urbanicity				
Rural	Ref.	Ref.	Ref.	Ref.
Urban	0.02 (-0.13, 0.16)	-0.14 (-0.34, 0.05)	0.37** (0.12, 0.61)	0.12 (-0.30, 0.53)
Model at baseline	0.42*** (0.37, 0.47)	0.45*** (0.40, 0.49)	0.32*** (0.26, 0.38)	0.37*** (0.32, 0.42)
Adjusted R-squared	0.351	0.278	0.185	0.238

Abbreviations: Ref.=Reference category; SA= Successful Aging; β=Beta coefficient; CI=Confidence Interval.
[a] Higher scores indicate more SA.
[b] Include no formal education received.
*p<0.05, **p<0.01, ***p<0.001.

Figure 1. Percentages of worsening, unchanged and improving in each Successful Aging model.



Intraclass correlation coefficient (ICC) for average/individual between baseline and follow-up are reported in each model. Weighted proportions are displayed.