Social engagement within the facility increased life expectancy in nursing home residents

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Authors' notes

This article presents independent research. The views expressed are those of the author(s) and not necessarily of the Instituto de Salud Carlos III.

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Abstract

Social engagement (SE) has been consistently shown to improve survival among community-dwelling older people, but the evidence in nursing home residents is inconclusive and prone to short-term reverse causation and confounding by major health determinants. A representative cohort of 382 nursing home residents in Madrid without severe physical and cognitive impairments at baseline was followed up for 10-year all-cause mortality. Standardized cumulative mortality curves for residents with low/null, moderate, and high levels of SE at baseline were estimated using Kaplan-Meier methods and spline-based survival models with inverse probability of exposure weights conditional on baseline sociodemographic characteristics, facility features, comorbidity, and disability. Standardized 5-year mortality risks and median survival times were compared across levels of SE. The baseline prevalences of low/null, moderate, and high SE were 36.0%, 44.2%, and 19.8%, respectively. A total of 268 residents died during 2,305 person-years of follow-up. Compared with residents with low/null SE at baseline, the standardized differences (95% confidence intervals) in 5-year mortality risk were −2.3% (−14.6% to 10.0%) for moderately engaged residents and −18.4% (−33.8% to −2.9%) for highly engaged residents. The median survival time increased by 0.4 (−1.4 to 2.2) and 3.0 (0.8 to 5.2) years, respectively. Residents with high SE within the nursing home had substantially lower mortality risk and longer median survival than residents with similar health determinants but low/null SE. The development of intervention programs, aimed at increasing SE among nursing home residents, could improve their long-term survival with an inherent gain in quality of life.

***Keywords**:* Cohort study; inverse probability weighting; mortality; nursing homes; social engagement.

Introduction

The World Health Organization recommends the promotion of active ageing as a way to enhance not only the physical and mental health status of older people, but also their active participation in society according to their needs, desires, and capacities.[1] Social connections and personal relationships generally decrease in old age, and there is evidence that – irrespective of other health determinants – lack of emotional support and loneliness are independently associated with increased risk for long-term all-cause mortality among older adults living in the community.[2, 3] In a residential setting, the subsequent loss of prior social networks in the community may further increase the likelihood of social isolation. Hence, meaningful interactions between residents and active participation in organized facility activities could play an important role in maintaining social engagement (SE).[4] However, the direct evidence linking SE to longer survival in nursing home residents is limited and inconclusive, as some cohort studies[5, 6] had short 1-year follow-up periods that could make them difficult to rule out a possible reverse causation bias; low levels of SE may reflect undetected frailty conditions near death. Furthermore, other long-term cohorts lacked representative samples of institutionalized older people, or failed to properly adjust for potential confounding from the main common independent determinants of SE and mortality.[7-9]

Therefore, this study aims to analyze the potential causal relation between SE in nursing homes and long-term all-cause mortality in a representative sample of nursing home residents in Madrid – by using inverse probability of exposure weighting to adjust for differences in other health determinants.

Methods

Study Population

This prospective cohort study used mortality follow-up data from a baseline survey conducted from June 1998 through to June 1999, in a representative sample of residents aged 65 years or older in nursing homes in Madrid, Spain. Study participants were selected through stratified cluster sampling, by first selecting 25 public/subsidized and 30 private nursing homes with probability proportional to their size, and then randomly sampling 10 men and 10 women from each selected public/subsidized facility, and 5 men and 5 women from each private institution. Of the 800 sample residents, 85 subjects declined to participate (overall response rate 89%) and 39 of these were randomly substituted with residents of the same facility and sex, yielding 754 participants in the baseline survey. As a result of this design, residents in public/subsidized facilities and men were oversampled; consequently, sampling weights were assigned to study participants as the inverse of their selection probabilities.

The Institute of Health Carlos III Research Ethics Committee approved the study. Informed consent was obtained verbally and documented from all study participants or their next of kin.

Baseline Data Collection

Structured questionnaires were administered by trained geriatricians and residents in geriatrics to all selected residents, their main caregivers, and the facility physicians to collect baseline data on sociodemographic characteristics, internal SE, external visits, medical conditions, functional dependency, cognitive status, and behavioral problems. Age, sex,

educational level, marital status, and length of stay in the nursing home were obtained by interviewing residents.

Residents' SE levels within the nursing homes were determined in relation to each resident's degree of interaction with other residents, and to their level of active participation in the facilities' activities; this was assessed by the study subjects (86%) or their main caregivers (if assigned, 14%) as low/null, moderate, or high. The frequency of external visits was also measured and classified as monthly or less, weekly, or daily.

We ascertained chronic medical conditions by interviewing facility physicians (or nurses for 8% of residents) with access to medical histories. These included cancer, chronic obstructive pulmonary disease, arrhythmias, ischemic heart disease, congestive heart failure, peripheral arterial disease, stroke, hypertension, diabetes, anemia, Alzheimer's disease, other dementias, Parkinson's disease, epilepsy, depression, anxiety disorders, and arthritis. Dementia was defined as a physician's diagnosis of Alzheimer's disease or other dementias. The number of chronic conditions other than dementia was computed and categorized into 0–1, 2–3, and ≥4 diseases.

Functional dependency in performing basic activities of daily living was assessed by residents or their main caregivers using a modified Barthel index.[10] Based on previously proposed cut-offs,[10] residents were classified as functionally independent (100 points), mildly dependent (91–99 points), moderately dependent (61–90 points), and severely or totally dependent (0–60 points).

Cognitive status was evaluated using the Short Portable Mental Status Questionnaire (0–10 errors),[11] which was adapted to the institutional setting; and the Minimum Data Set Cognition Scale (0–10 points),[12] which obtained an assessment from the main caregivers based on particular Minimum Data Set questions. Severe cognitive impairment was defined as 8 or more education-adjusted errors in the Short Portable Mental Status Questionnaire or 9 or more points on the Minimum Data Set Cognition Scale. Residents with behavioral problems related to verbal, physical abuse, or inappropriate/disruptive behavior during the previous week were identified through the corresponding Minimum Data Set questions.

Mortality Ascertainment during Follow-Up

All-cause mortality was ascertained up to September 2013 by requesting updated data on residents' vital status from participating facilities, and via computerized linkage to the Spanish National Death Index, which includes all deaths registered in Spain.[13] Residents contributed follow-up time from their 1998–1999 baseline interview until death, unless they were censored at 10 years of follow-up, or age 105 years, whichever came first.

Statistical Methods

The cumulative all-cause mortality curves for each baseline level of SE within the nursing home (low/null, moderate, or high) were standardized to the weighted distribution of baseline confounders in the overall institutionalized population by using inverse probability weighting. We first fitted a sampling-weighted polytomous logistic model to estimate each resident's probability of being in their own level of SE given the observed confounders. Standardization weights were calculated as the inverse of these conditional probabilities of exposure, and this was further rescaled by the sampling-weighted proportions in each level of SE – to reduce variability of weights and avoid influential observations with extreme weights.[14] We then assigned combined weights to residents as the product of the sampling weights, which

corrected the sample for selection bias to represent the population and standardization weights which adjusted for confounding.[15]

Three increasingly comprehensive sets of baseline confounders were included in the polytomous logistic model for baseline SE. The first model included baseline sociodemographic characteristics, such as age (65–74, 75–79, 80–84, 85–89, or ≥90 years), sex (women or men), educational level (less than primary; primary; or secondary or more), and marital status (married, single, or widowed/divorced). The second model additionally controlled for facility ownership (public/subsidized or private), facility size (<100, 100–299, or ≥300 beds), length of stay (0–1, 2–4, or ≥5 years), assigned caregiver (yes or no), and frequency of external visits (monthly or less, weekly, or daily). The third model further adjusted for baseline multimorbidity and disability, including number of chronic conditions (0–1, 2–3, or ≥4) and functional dependency (no, mild, or moderate). The mean (range) combined weights, taking into account both sampling and standardization based on these models, were Model 1 0.99 (0.18–3.25), Model 2 0.99 (0.14–4.12), and Model 3 0.98 (0.13–3.77) (**Supplementary Figure 1**). This weighting procedure provided effective standardization; this is shown by the fact that the fully-weighted distributions of baseline confounders were nearly identical across the different levels of SE, and also closely matched their sampling-weighted distributions in the overall institutionalized population (**Supplementary Table 1**).

For mortality risk analyses, we used Kaplan-Meier methods and spline-based survival models[16] weighted by combined weights and stratified by baseline level of SE to obtain nonparametric and smooth estimates of the cumulative mortality curves that would have been observed in the overall institutionalized population if every resident had been in each level of SE.[17]Spline-based models parameterized stratum-specific log cumulative hazards as distinct natural cubic splines of log time with two internal knots at the 33th and 67th percentiles.[16] We used weighted spline-based survival models to estimate standardized differences in cumulative mortality at 2, 5, and 10 years of follow-up, and compared moderate and high with low/null SE. The 95% confidence intervals (CIs) were derived from robust standard errors of spline coefficients by applying delta methods. We also estimated standardized differences in the median survival time and their 95% CIs across the different levels of SE.

We evaluated heterogeneity in risk differences across pre-specified subgroups defined by baseline age (65–84 or ≥85 years), sex (women or men), facility ownership (public/subsidized or private), facility size (<300 or ≥300 beds), and baseline functional dependency (no or mild/moderate) by fitting spline-based survival models weighted by combined weights and stratified by baseline level of SE and resident subgroup. Combined weights for subgroup analyses were calculated as the product of sampling weights and subgroup-specific standardization weights. This was to standardize cumulative mortality curves for each SE level and resident subgroup to the weighted distribution of confounders in the entire resident subgroup.[14] We estimated standardized differences in 5-year cumulative mortality and 95% Cis, which compared moderate and high with low/null SE at baseline within each subgroup, and tested for heterogeneity across subgroups by using joint Wald tests. Statistical analyses were performed using the *stpm* command in Stata, version 14 (Stata Corp., College Station, Texas) and graphics were produced in R, version 3 (R Foundation for Statistical Computing, Vienna, Austria).

Results

Of the 754 participants in the baseline survey, we excluded 32 residents (4.2%) with missing information for one or more baseline covariate, and a further 55 (7.3%) with unknown vital status at the end of follow-up. We also excluded 270 residents (35.8%) with severe or total functional dependency, severe cognitive impairment, physician's diagnosis of dementia, or behavioral problems at baseline, since this would probably influence their engagement in social activities. Additionally 15 participants (2.0%) were excluded who had stays shorter than 60 days, so as to exclude most short-stay rehabilitation patients. Thus, the final cohort included 382 long-term residents without severe physical or cognitive impairments. There were 124 (36.0%) with low/null SE, 179 (44.2%) moderate SE, and 79 residents (19.8%) with high levels of SE at baseline. Highly engaged subjects were more likely to be younger, men, currently or previously married, residents in medium-sized private facilities, have had shorter stays, more frequent external visits, fewer chronic conditions, and lower degrees of functional dependency at baseline than those with low or moderate levels of SE (**Table 1**).

A total of 268 participants died during 2,305 person-years of follow-up (median follow-up 6.2 years), with an overall mortality rate of 10.9 deaths per 100 person-years. All-cause mortality was consistently lower after the first 2 years of follow-up among residents with high levels of SE at baseline, compared to those with low/null or moderate levels (**Figure 1);** this was after standardization to the overall weighted population distribution of sociodemographic characteristics, facility features, multimorbidity, and disability at baseline. Compared with residents with low/null levels of SE, the standardized mortality risk differences (95% CIs) at 5 and 10 years of follow-up were −2.3% (−14.6% to 10.0%) and 4.6% (−7.4% to 16.6%) for moderately engaged residents; and −18.4% (−33.8% to −2.9%) and −7.5% (−24.2% to 9.3%) for highly engaged residents (**Table 2**, Model 3). Similarly, the fully-standardized differences (95% CIs) in the median survival time when comparing residents with low/null SE at baseline were 0.4 (−1.4 to 2.2) years for moderate SE and 3.0 (0.8 to 5.2) for high SE.

In subgroup analyses, the standardized differences in 5-year mortality risk for moderate versus low/null SE at baseline reached −16.0% in residents aged 85 years or older and −17.8% in men, whereas the standardized 5-year risk differences for high versus low/null SE increased to −38.0% in older residents and −35.2% in private facilities (**Figure 2**). Nevertheless, no significant heterogeneity in risk differences was detected across any resident subgroup and the limited sample size resulted in imprecise estimates in some subgroups.

Discussion

Residents with high SE levels within the nursing home had better 5-year overall survival rates when compared with residents with low/null levels of SE. Furthermore, this association was independent of baseline sociodemographic characteristics, facility features, multimorbidity, disability and frequency of contact with people outside the nursing home. Moreover, residents with high internal SE had a 3-year increase in the median survival time when compared with residents with low/null SE. We also found that this benefit in 5-year overall survival was more notable for over-85s and those in private facilities.

SE encompasses a great variety of activities, most of which have consistently been shown to be associated with better physical and mental health.[18] In addition, the hypothesis supported by our results – greater SE improving survival – has biological plausibility. Perceived social isolation in humans seems to affect physiological responses, with adverse chronic

consequences like activation of the hypothalamic-pituitary-adrenal axis, glucocorticoid insensitivity, alteration of the immune system[19] and increased risk for inflammatory disease.[20]Inflammation and oxidation generate a vicious circle that damages protein, carbohydrates, lipids, and DNA and its repair,[21, 22] and predisposes those affected to many chronic disorders.[22]

As far as we know, only three recent studies carried out with nursing home residents have assessed the relation between SE and mortality over follow-up periods longer than 1 year. Hjaltadottir et al.'s multicenter study found an increased 3-year mortality risk in residents with lower SE compared to those with high SE, but adjustment was limited to just age and gender. [9] In a study based on a large facility, Kiely et al. reported that residents who did not engage socially were 1.4 times more likely to die during a 4-year follow-up period, when compared with the most socially engaged residents and after adjustment for the main confounders. [8] Cohen-Mansfield et al. in an 11-year follow-up study in a nursing home, found a positive association between social network quality and survival, but this relation weakened after adjustment for the main confounders.[7]

It is worth noting some of the limitations of the current study. First, as this study was a secondary analysis of data, we did not use a standardized scale to evaluate SE; it was estimated through a specific question about the degree of interaction with other residents in the facility and degree of active participation in facility activities, with the responses assigned to a 3-category scale. Second, SE and the main covariates were only measured at baseline, so we cannot exclude that those variables may have changed over the follow-up period, and that modification could have influenced the outcome. Third, some deaths may have not been recorded. This possible limitation would have probably generated a non-differential misclassification and potentially attenuated the associations found. Fourth, we did not adjust for frailty, which could be associated with both SE and mortality. However, we did control for functional dependency and comorbidities among other co-variates, which could collectively serve as effective proxies for frailty and other potential confounders. This suggests that our results are robust. Furthermore, our study design and statistical procedures embraced the basic elements of an intervention study, like exclusion criteria – which limited confounding by restricting important confounding categories – and inverse probability weighting – which tries to emulate a random assignment of study participants to each of the study groups. All of this will have reduced confounding to a minimum. Thus, assuming a limited influence of unmeasured confounding, this design might be assimilated to an intervention trial of a hypothetical SE program with perfect compliance. Other strengths worth mentioning are that our study used a probabilistic sample of the nursing home population, with a high response rate and long follow-up, and measurements obtained directly by trained interviewers.

Conclusions and Implications

Residents with high SE within the nursing home had lower mortality risk when compared with residents with low/null SE. This association was independent of sociodemographic characteristics, facility features, comorbidities, disability and frequency of contact with people outside the nursing home.

Participation in varied activities within the facility has been shown to be very beneficial for physical and mental health,[18] and our study provides convincing results regarding survival for people living in care homes. Furthermore, what is important is that this increase in life

expectancy also occurs in a way that surely improves quality of life, as opposed to life prolongation through aggressive treatment strategies – which may increase survival but at the cost of undermining quality of life.

However, SE requires the facility managers and staff to be proactive not only by putting in place activities that encourage personal contact, but also by fighting against the impediments which are habitual in such institutions. This may be because many residents are very passive or reticent, or the staff have an excessive workload, among other barriers.[23]

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Conflicts of interest*:* The authors declare no conflicts of interest.

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Table 1. Baseline characteristics of residents by level of social engagement in nursing homes in Madrid, Spain, 1998–1999.*

Characteristic	Overall	Level of social engagement			*P* value†
		Low/null	Moderate	High	
No. of residents	382 (100)	124 (36.0)	179 (44.2)	79 (19.8)	
Age (years)					0.03
65–74	61 (15.7)	15 (13.3)	27 (11.6)	19 (29.4)	
75–79	70 (16.4)	21 (17.3)	33 (15.1)	16 (17.4)	
80–84	102 (25.6)	31 (21.2)	50 (30.0)	21 (24.1)	
85–89	81 (23.8)	37 (30.6)	34 (22.8)	10 (13.4)	
≥90	68 (18.5)	20 (17.6)	35 (20.5)	13 (15.7)	
Sex					0.01
Women	200 (74.4)	79 (82.8)	87 (70.9)	34 (66.9)	
Men	182 (25.6)	45 (17.2)	92 (29.1)	45 (33.1)	
Educational level					0.78
Less than primary	188 (45.3)	60 (41.8)	90 (49.0)	38 (43.3)	
Primary	143 (40.2)	49 (44.3)	66 (36.9)	28 (39.9)	
Secondary or more	51 (14.6)	15 (13.9)	23 (14.1)	13 (16.8)	
Marital status					0.35
Married	68 (14.2)	16 (11.3)	36 (15.3)	16 (17.1)	
Single	113 (33.7)	44 (40.6)	51 (30.9)	18 (27.3)	
Widowed/divorced	201 (52.1)	64 (48.1)	92 (53.8)	45 (55.5)	
Facility ownership					0.10
Public/subsidized	285 (61.4)	89 (57.7)	142 (68.2)	54 (52.7)	
Private	97 (38.6)	35 (42.3)	37 (31.8)	25 (47.3)	
Facility size (beds)					0.15
<100	51 (20.8)	18 (21.8)	22 (20.3)	11 (20.0)	
100–299	138 (37.1)	47 (38.9)	56 (30.6)	35 (48.4)	
≥300	193 (42.1)	59 (39.3)	101 (49.1)	33 (31.6)	
Length of stay (years)					0.01
0–1	117 (29.0)	29 (22.3)	56 (28.6)	32 (42.2)	
2–4	122 (31.9)	40 (32.4)	54 (29.0)	28 (37.3)	
≥5	143 (39.1)	55 (45.3)	69 (42.4)	19 (20.4)	
Assigned caregiver					0.47
Yes	57 (13.6)	18 (11.6)	29 (16.1)	10 (11.5)	
No	325 (86.4)	106 (88.4)	150 (83.9)	69 (88.5)	
Frequency of external visits					0.22
Monthly or less	144 (33.6)	54 (37.9)	71 (35.0)	19 (22.7)	
Weekly	168 (45.4)	46 (39.0)	80 (47.2)	42 (53.0)	
Daily	70 (21.0)	24 (23.2)	28 (17.8)	18 (24.3)	
No. of chronic conditions					0.27
0–1	109 (30.0)	33 (32.0)	44 (24.6)	32 (38.6)	

2–3	174 (45.9)	57 (42.6)	84 (49.4)	33 (44.1)	
≥4	99 (24.1)	34 (25.4)	51 (26.0)	14 (17.3)	
Functional dependency					0.08
No	152 (35.0)	40 (29.7)	69 (33.4)	43 (48.2)	
Mild	128 (34.5)	41 (33.3)	67 (39.4)	20 (26.0)	
Moderate	102 (30.5)	43 (37.0)	43 (27.3)	16 (25.8)	

* Unweighted counts (sampling-weighted percentages).

† *P* value for homogeneity of sampling-weighted percentages across levels of social engagement.

Table 2. Standardized differences in cumulative all-cause mortality at 2, 5, and 10 years of follow-up by level of social engagement at baseline among residents in nursing homes in Madrid, Spain, 1998–1999 to 2009.

	Level of social engagement at baseline		
	Low/null	**Moderate**	**High**
No. of person-years	691.1	1,042.2	571.6
No. of deaths	92	133	43
Mortality rate*	11.6	12.8	6.6
2-year follow-up			
Cumulative mortality† (%)	11.8	18.8	8.1
Standardized risk difference‡ (95% CI)			
Model 1§	0.0 (reference)	3.9 (−4.4 to 12.1)	−6.5 (−15.0 to 1.9)
Model 2||	0.0 (reference)	5.0 (−3.5 to 13.4)	−2.3 (−13.9 to 9.3)
Model 3¶	0.0 (reference)	6.5 (−2.3 to 15.4)	−0.6 (−11.8 to 10.7)
5-year follow-up			
Cumulative mortality† (%)	47.4	46.2	20.1
Standardized risk difference‡ (95% CI)			
Model 1§	0.0 (reference)	−3.7 (−15.6 to 8.2)	−24.3 (−37.4 to −11.1)
Model 2||	0.0 (reference)	−4.5 (−16.7 to 7.8)	−22.5 (−38.2 to −6.7)
Model 3¶	0.0 (reference)	−2.3 (−14.6 to 10.0)	−18.4 (−33.8 to −2.9)
10-year follow-up			
Cumulative mortality† (%)	68.9	74.4	50.5
Standardized risk difference‡ (95% CI)			
Model 1§	0.0 (reference)	4.3 (−7.3 to 15.9)	−9.4 (−25.8 to 7.1)
Model 2||	0.0 (reference)	3.8 (−7.7 to 15.3)	−9.3 (−26.0 to 7.4)
Model 3¶	0.0 (reference)	4.6 (−7.4 to 16.6)	−7.5 (−24.2 to 9.3)

* Sampling-weighted mortality rates per 100 person-years.
† Unstandardized cumulative mortality risks at the specified follow-up times were obtained from sampling-weighted Kaplan-Meier methods stratified by level of social engagement at baseline.
‡ Standardized differences in cumulative mortality at the specified follow-up times which compared levels of social engagement at baseline were obtained from spline-based survival models weighted by combined inverse probability weights and stratified by level of social engagement. 95% confidence intervals (CIs) were derived from robust standard errors of spline coefficients by applying delta methods.
§ Model 1 was standardized for baseline age (65–74, 75–79, 80–84, 85–89, or ≥90 years), sex (women or men), educational level (less than primary, primary, or secondary or more), and marital status (married, single, or widowed/divorced).
|| Model 2 was further standardized for baseline facility ownership (public/subsidized or private), facility size (<100, 100–299, or ≥300 beds), length of stay (0–1, 2–4, or ≥5 years), assigned caregiver (yes or no), and frequency of external visits (monthly or less, weekly, or daily).
¶ Model 3 was further standardized for baseline number of chronic conditions (0–1, 2–3, or ≥4) and functional dependency (no, mild, or moderate).

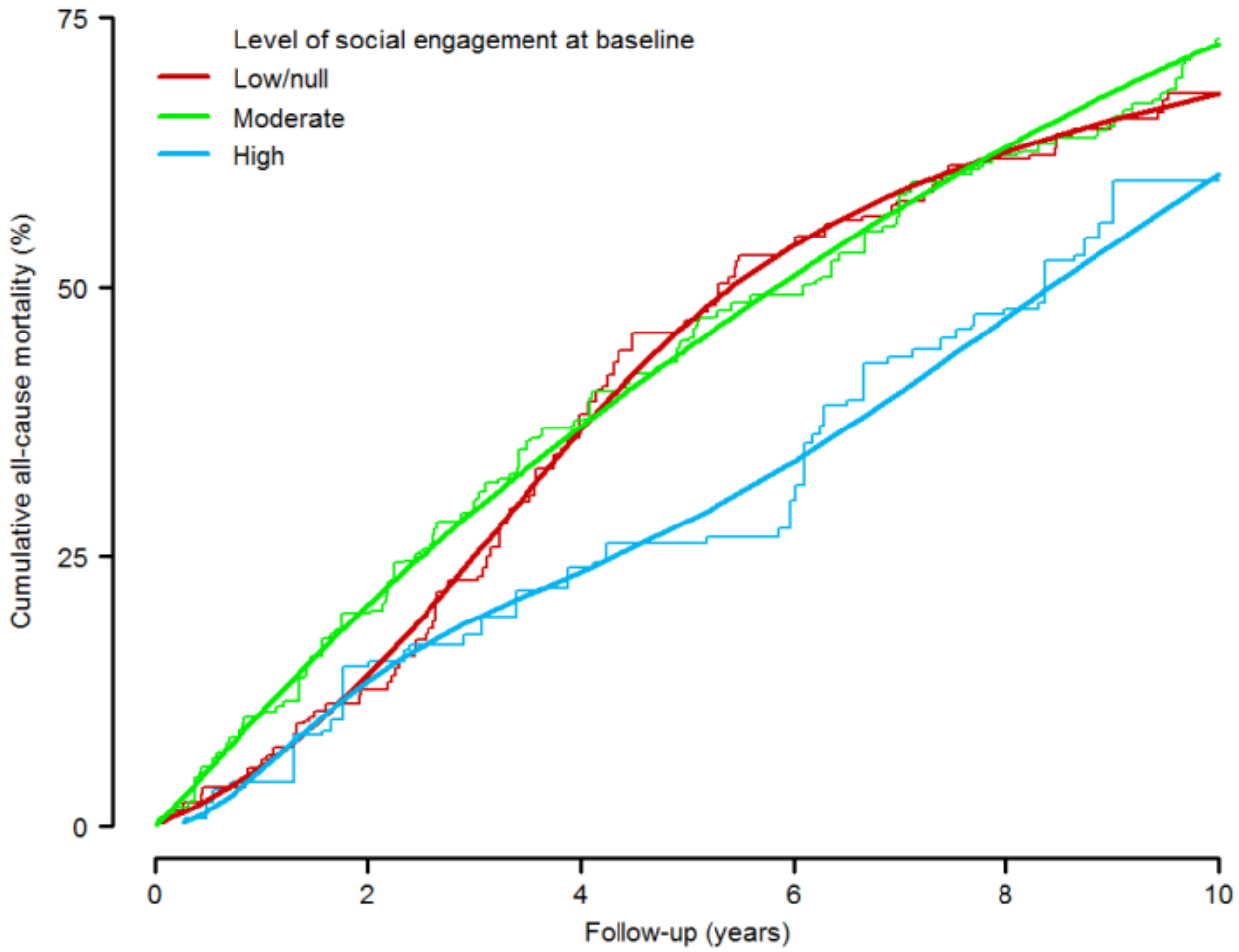
Figure Legends

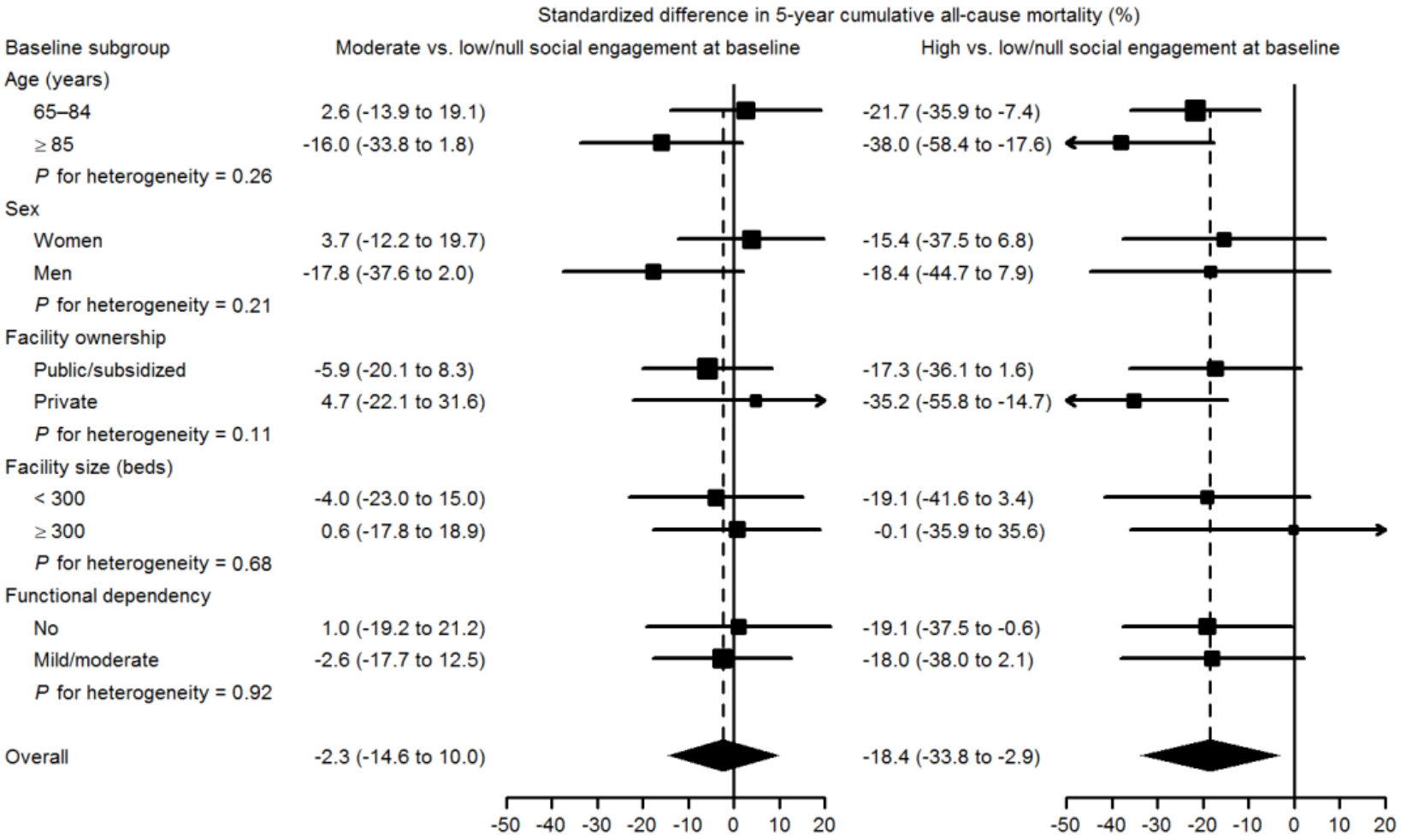
Figure 1. Standardized cumulative all-cause mortality by level of social engagement at baseline among residents in nursing homes of Madrid, Spain, 1998–1999 to 2009.

Parametric cumulative mortality curves (smooth lines) were estimated from a spline-based survival model and nonparametric cumulative mortality curves (step functions) from Kaplan-Meier methods, both weighted by combined inverse probability weights and stratified by baseline level of social engagement. Combined weights were used to standardize cumulative mortality curves in each level of social engagement to the weighted distribution of baseline confounders in the overall institutionalized population, including age (65–74, 75–79, 80–84, 85–89, or ≥90 years), sex (women or men), educational level (less than primary, primary, or secondary or more), marital status (married, single, or widowed/divorced), facility ownership (public/subsidized or private), facility size (<100, 100–299, or ≥300 beds), length of stay (0–1, 2–4, or ≥5 years), assigned caregiver (yes or no), frequency of external visits (monthly or less, weekly, or daily), number of chronic conditions (0–1, 2–3, or ≥4), and functional dependency (no, mild, or moderate).

Figure 2. Standardized differences in 5-year cumulative all-cause mortality comparing moderate and high with low/null social engagement at baseline in pre-specified subgroups of residents in nursing homes in Madrid, Spain, 1998–1999 to 2009.

Subgroup-specific risk differences (squares with area inversely proportional to the variance) and their 95% confidence intervals (horizontal lines) were obtained from spline-based survival models weighted by combined inverse probability weights and stratified by baseline level of social engagement and resident subgroup. Subgroup-specific weights were used to standardize cumulative mortality in each social engagement level and resident subgroup to the weighted distribution of baseline confounders in the entire resident subgroup, including age (65–74, 75–79, 80–84, 85–89, or ≥90 years), sex (women or men), educational level (less than primary; primary; or secondary or more), marital status (married, single, or widowed/divorced), facility ownership (public/subsidized or private), facility size (<100, 100–299, or ≥300 beds), length of stay (0–1, 2–4, or ≥5 years), assigned caregiver (yes or no), frequency of external visits (monthly or less, weekly, or daily), number of chronic conditions (0–1, 2–3, or ≥4), and functional dependency (no, mild, or moderate).


Level of social engagement at baseline
Low/null
Moderate
High
Cumulative all-cause mortality (%)
75
50
25
0
0
2
4
6
8
10
Follow-up (years)


Standardized difference in 5-year cumulative all-cause mortality (%)
Baseline subgroup
Moderate vs. low/null social engagement at baseline
High vs. low/null social engagement at baseline
Age (years)
65–84
2.6 (-13.9 to 19.1)
-21.7 (-35.9 to -7.4)
≥ 85
-16.0 (-33.8 to 1.8)
-38.0 (-58.4 to -17.6)
P for heterogeneity = 0.26
Sex
Women
3.7 (-12.2 to 19.7)
-15.4 (-37.5 to 6.8)
Men
-17.8 (-37.6 to 2.0)
-18.4 (-44.7 to 7.9)
P for heterogeneity = 0.21
Facility ownership
Public/subsidized
-5.9 (-20.1 to 8.3)
-17.3 (-36.1 to 1.6)
Private
4.7 (-22.1 to 31.6)
-35.2 (-55.8 to -14.7)
P for heterogeneity = 0.11
Facility size (beds)
< 300
-4.0 (-23.0 to 15.0)
-19.1 (-41.6 to 3.4)
≥ 300
0.6 (-17.8 to 18.9)
-0.1 (-35.9 to 35.6)
P for heterogeneity = 0.68
Functional dependency
No
1.0 (-19.2 to 21.2)
-19.1 (-37.5 to -0.6)
Mild/moderate
-2.6 (-17.7 to 12.5)
-18.0 (-38.0 to 2.1)
P for heterogeneity = 0.92
Overall
-2.3 (-14.6 to 10.0)
-18.4 (-33.8 to -2.9)
-50 -40 -30 -20 -10 0 10 20
-50 -40 -30 -20 -10 0 10 20

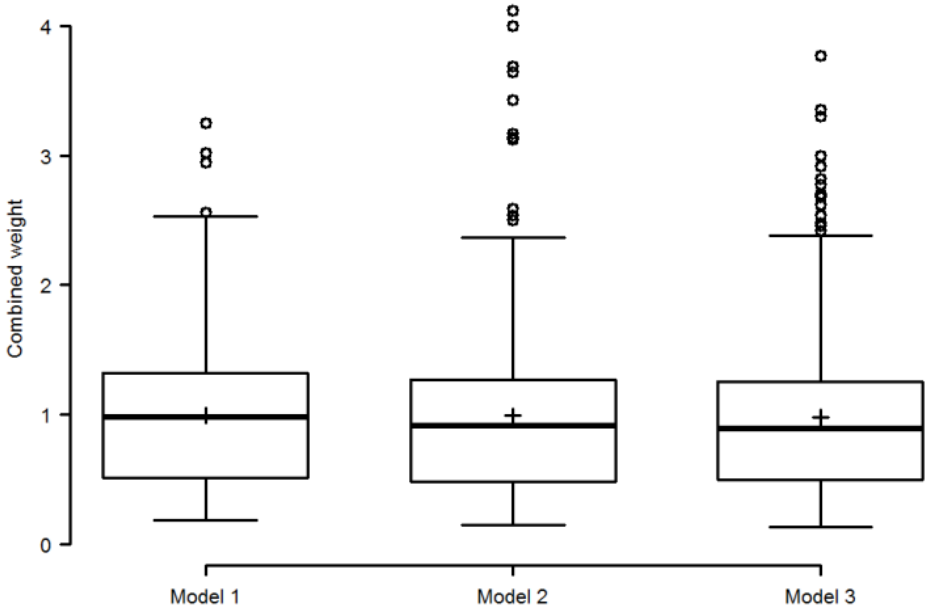
Supplementary Table 1. Distribution of baseline characteristics by level of social engagement after standardization to the overall institutionalized population in Madrid, Spain.

		Level of social engagement†			
Characteristic	**Overall***	**Low/null**	**Moderate**	**High**	***P* value‡**
Age (years)					1.00
65–74	15.7	14.7	14.9	18.1	
75–79	16.4	15.0	15.8	15.2	
80–84	25.6	28.8	27.3	29.4	
85–89	23.8	24.1	23.3	21.3	
≥90	18.5	17.6	18.7	16.0	
Sex					0.90
Women	74.4	73.2	71.8	70.2	
Men	25.6	26.8	28.2	29.8	
Educational level					0.99
Less than primary	45.3	47.8	46.4	45.8	
Primary	40.2	40.0	39.5	42.1	
Secondary or more	14.6	12.2	14.2	12.1	
Marital status					0.90
Married	14.2	13.1	14.3	17.7	
Single	33.7	31.5	32.8	26.3	
Widowed/divorced	52.1	55.4	53.0	56.0	
Facility ownership					0.99
Public/subsidized	61.4	63.8	63.4	64.2	
Private	38.6	36.2	36.6	35.8	
Facility size (beds)					0.87
<100	20.8	19.2	19.6	16.3	
100–299	37.1	38.5	36.7	46.0	
≥300	42.1	42.3	43.7	37.7	
Length of stay (years)					0.89
0–1	29.0	30.4	29.3	32.5	
2–4	31.9	31.5	32.1	36.9	
≥5	39.1	38.1	38.5	30.5	
Assigned caregiver					0.72
No	86.4	87.9	85.0	83.4	
Yes	13.6	12.1	15.0	16.6	
Frequency of external visits					0.99
Monthly or less	33.6	34.5	36.3	33.5	
Weekly	45.4	45.1	44.9	44.1	
Daily	21.0	20.4	18.8	22.4	
No. of chronic conditions					0.71
0–1	30.0	29.1	29.2	39.7	
2–3	45.9	47.3	47.3	40.3	
≥4	24.1	23.6	23.4	20.0	
Functional dependency					0.95
No	35.0	34.3	34.5	38.5	
Mild	34.5	34.9	35.0	28.8	
Moderate	30.5	30.8	30.5	32.7	

* Sampling-weighted percentages.

† Fully-weighted percentages taking into account both sampling and standardization weights.

‡ *P* value for homogeneity of fully-weighted percentages across levels of social engagement.



Supplementary Figure 1. Distribution of combined weights taking into account both sampling and standardization based on the three polytomous logistic models for baseline social engagement in care homes in Madrid, Spain.

Boxes represent the mean (+), median (middle horizontal line), quartiles (border horizontal lines), and individual outlying weights (circles).