The relationship between wealth and loneliness among older people across Europe: Is social participation protective?

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Research highlights

- Loneliness among older people is an increasing public health concern
- Loneliness and social participation are socially patterned by wealth
- Social participation may protect against loneliness associated with low wealth

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Abstract

OBJECTIVE: 1. Examine the relationship between household wealth, social participation and loneliness among older people across Europe. 2. Investigate whether relationships vary by type of social participation (charity/volunteer work, sports/social clubs, educational/training course, and political/community organisations) and gender. 3. Examine whether social participation moderates the association between wealth and loneliness. METHODS: Data (N=29,795) were taken from the fifth wave of the Survey of Health, Ageing and Retirement in Europe (SHARE), which was collected during 2013 from 14 European countries. Loneliness was measured using the short version of the Revised-University of California, Los Angeles (R-UCLA) Loneliness Scale. We used multilevel logistic models stratified by gender to examine the relationships between variables, with individuals nested within countries. RESULTS: The risk of loneliness was highest in the least wealthy groups and lowest in the wealthiest groups. Frequent social participation was associated with a lower risk of loneliness and moderated the association between household wealth and loneliness, particularly among men. Compared to the wealthiest men who often took part in formal social activities, the least wealthy men who did not participate had greater risk of loneliness (OR=1.91, 95% CI: 1.44 to 2.51). This increased risk was not observed among the least wealthy men who reported frequent participation in formal social activities (OR=1.12, 95% CI: 0.76 to 1.67). CONCLUSION: Participation in external social activities may help to reduce loneliness among older adults and potentially acts as a buffer against the adverse effects of socioeconomic disadvantage.

Introduction

European societies are facing unprecedented demographic change due to increasing longevity and declining birth rates. It is estimated that the proportion of people aged 65 years and over in the European Union will increase to around 30% of the total population by 2060, and the proportion of people aged over 80 years will more than double, reaching 12% of the population (Davies, 2014). Although life expectancy is approximately 5.5 years higher for women, the gender difference in healthy life-years is considerably narrower, only 0.1 years in 2013 (Eurostat, 2015). As a consequence, future years will likely see a greater number of elderly individuals, particularly women, living alone and experiencing multiple health conditions. This may lead to an increasing number of people affected by feelings of loneliness and social isolation, which may particularly impact on the least advantaged in society.

Loneliness is thought to arise as a result of the deficit between the actual and expected number, or quality, of social interactions and relations (Yang and Victor, 2011). It is equivalent to feelings of social isolation, but is not the same as objective social isolation, when individuals are actually lacking in social contact or relationships (Hawkley and Cacioppo, 2010). Therefore, it is possible to be married and have a rich social life, but still experience a feeling of loneliness, and also to live with little social contact and not feel socially isolated. Loneliness is associated with an increased mortality risk (by 26% in a recent meta-analysis), making it comparable to well-established risk factors such as smoking and physical inactivity (Holt-Lunstad et al., 2015). Longitudinal studies demonstrate that loneliness is associated with increased blood pressure and incident coronary heart disease (Hawkley et al., 2010; Thurston and Kubzansky, 2009), as well as a decline in cognitive function and increased risk of late-life dementia, especially among those with fewer educational qualifications (Shankar et al., 2013; Wilson et al., 2007). Higher levels of loneliness are also linked to more physician consultations (Ellaway et al., 1999; Gerst-Emerson and Jayawardhana, 2015). Preventing loneliness is therefore an increasing public health priority (Equal Opportunities Committee, 2015; Nicole and Hanratty, 2012).

Loneliness is influenced by a myriad of factors including age, marital status, social networks and participation, functional limitations and mental health (Aartsen and Jylha, 2011; Bosma et al., 2015; Cacioppo et al., 2010; Fokkema et al., 2012; Hansen and Slagsvold, 2015). Loneliness affects individuals of any age (Yang and Victor, 2011), but older people are particularly susceptible as a result of losing close friends and relatives, as well as the increased prevalence of limiting health conditions. Gender differences in loneliness exist; older women frequently report higher levels of loneliness compared to men (Fokkema et al., 2012; Hansen and Slagsvold, 2015). These differences are largely explained by health status, living arrangements and socioeconomic position (Hansen and Slagsvold, 2015). Gender may also moderate the influence of particular risk factors for loneliness. For

example, divorced men report higher levels of loneliness compared to women, which may be due to the greater sense of support they generally derive from a partner and smaller support networks (Dykstra and Fokkema, 2007). In addition, several studies demonstrate that participation in formal activities, such as volunteering and attending social clubs, is associated with reduced loneliness in later life (Croezen et al., 2015; Gilmour, 2012; Heaven et al., 2013).

A disadvantaged socioeconomic position is linked with loneliness (Aylaz et al., 2012; Bosma et al., 2015; Hansen and Slagsvold, 2015; Victor et al., 2005), but in general, studies have rarely adopted an inequalities lens. Socioeconomic inequalities in loneliness may arise via a number of pathways. Individuals with less income or wealth may not have the financial resources to fully participate in society and visit friends and family. They are more likely to have limiting physical and mental health conditions that make it more difficult to leave home, navigate the local environment, and interact with others. Those with a disadvantaged socioeconomic position are more likely to be widowed; one of the strongest risk factors for loneliness (Pinquart, 2003). Individuals with fewer educational qualifications also may not have had as many opportunities to develop social networks as those with higher education, as a result of longer working hours, the increased risk of unemployment and insecure employment throughout the life course (Näswall and De Witte, 2003).

Opportunities for social contact may lessen in older age as individuals retire from the labour force, potentially losing their social roles and associated sense of purpose and identity (Heaven et al., 2013). Whilst participation in formal social activities may help prevent loneliness in later life, several barriers to social participation exist, including disability, a lack of supportive community environment and diminished financial resources (Goll et al., 2015). It is therefore plausible that social participation may widen or narrow socioeconomic inequalities in loneliness. If those in a more advantaged socioeconomic position are more likely to participate in community groups and events, inequality may increase. However, inequalities in loneliness may narrow if those in a disadvantaged position benefit more from social participation.

The present study takes a social inequalities approach to loneliness and focuses on the influence of social participation, defined by attending external activities, such as social clubs or volunteering. It aims to first describe the relationship between wealth, social participation and loneliness among older people across Europe. Second, it examines whether the relationships differ by type of social participation and gender. Third, it investigates whether social participation may moderate any relationship between wealth and loneliness.

Methods

Data

Data were taken from the fifth wave (release 1.1.0) of the Survey of Health, Ageing and Retirement in Europe (SHARE) (Börsch-Supan, 2015), collected during 2013. It included a representative sample of non-institutionalised individuals born in 1962 or earlier who had their regular domicile in the respective country (Austria, Belgium, Switzerland, Czech Republic, Germany, Denmark, Estonia, Spain, France, Italy, Luxembourg, Netherlands, Sweden and Slovenia). Spouses or partners were also eligible to be interviewed, regardless of age (Börsch-Supan et al., 2013) and were included in the analyses. Data were collected by face-to-face computer assisted personal interviewing (CAPI) and all aspects of the survey, including translation procedures, are subject to strict quality standards (Börsch-Supan et al., 2013). Further methodological details about the survey can be found elsewhere (Malter and Börsch-Supan, 2015). We included individuals aged 65 years or over who were not in the paid labour force (N=31,639), a subset of the original SHARE sample. This included individuals who self-reported as retired, unemployed, looking after the home or family, or permanently sick or disabled, which is consistent with previous research (Coe and Zamarro, 2011).

Outcome

Loneliness was measured using the short version of the Revised-University of California at Los Angeles Loneliness scale (R-UCLA) (Hughes et al., 2004), which is a frequently used and validated indicator of loneliness (Boss et al., 2015; Samuel et al., 2015), particularly within the United States and United Kingdom (Luo et al., 2012; Pikhartova et al., 2014; Steptoe et al., 2013). The scale was recently harmonised for use in SHARE (Malter and Börsch-Supan, 2013), and few studies have used it in a cross-national context, to date (Shiovitz-Ezra, 2015; Wagner and Brandt, 2015). It includes the following three questions: how much of the time do you feel a lack of companionship; how much of the time do you feel left out; how much of the time do you feel isolated from others? The answers are recorded using three categories: often, some of the time, hardly ever/never. These form a scale that ranges from three to nine, whereby three corresponds to not feeling lonely and nine indicates the highest level of loneliness. Previous research has often treated the measure as continuous (Hughes et al., 2004), however, the distribution of responses is not normal. Therefore, we converted it to a binary measure. Country-specific quartiles were calculated and we defined those who fell into the first, second and third quartiles as “not lonely” and those in the fourth quartile as “lonely”, similar to the method used in a previous paper (Pikhartova et al., 2014).

Independent variables

Wealth was selected as the primary measure of socioeconomic position as it reflects the accumulation of assets across the life course and may be a more appropriate measure of economic resources among retired populations (Demakakos et al., 2015). Self-reported wealth was measured by the sum of household financial (e.g. money in bank accounts, stocks or government bonds) and real (e.g. value of own residence or vehicle) assets, minus liabilities (e.g. mortgage or credit card debt). Wealth was equivalised using the Organisation for Economic Co-operation and Development (OECD) equivalence scale (OECD, 2006) and divided into country-specific quintiles. Missing values were multiply imputed by the SHARE team (De Luca et al., 2015).

Social participation was measured by a combination of questionnaire items that asked whether the respondents had, in the past 12 months, participated in voluntary or charity work, attended an educational or training course, gone to a sport, social or other kind of club, or taken part in a political or community-related organisation. Answers were categorised into a combined binary variable distinguishing those who participated in any of the above activities frequently (almost every day or week) or infrequently (almost every month, less often, or never). Sensitivity analysis was conducted, increasing the frequent social participation group to those who did so almost every day, week or month, but results were not substantively altered (results available on request). To examine differences by type of participation, we divided the social participation variable into four types (voluntary or charity work, education or training course, sport, social or other club, and political or community-related organisation) and classified frequency of participation as above.

Additional independent variables included age (five-year age-bands), immigrant status (born in current country of residence or not), marital status (married, separated or divorced, never married, or widowed), household size (one, two, or three or more), frequency of contact with own children (categorised into no children, daily, several times a week, about once a week, or less than weekly), limitations in functioning due to health problems (categorised into limited or not limited using the Global Activity Limitations Index) and education level. The Global Activity Limitations Index (GALI) is derived from the following question: "*for the past six months at least, to what extent have you been limited because of a health problem in activities people usually do?*". GALI is a comparable measure of functional ability across Europe (Jagger et al., 2010). Participants' highest education level was recorded using the International Standard Classification of Education (United Nations Educational Scientific and Cultural Organization, 2014) and divided into low (less than lower secondary education, or lower secondary education completed), medium (upper secondary education or post-secondary non-tertiary education completed) and high (tertiary education completed).

Analysis

We first descriptively examined the relationship between household wealth and loneliness. Multilevel logistic regression models were calculated to examine the relationships between variables, which allowed for the nesting of individuals within countries, using a random-intercept. We also calculated linear multilevel models as a sensitivity analysis, which treated the R-UCLA scale as continuous, but the substantive results were unchanged (results available on request). As we hypothesised *a priori* that relationships may differ by gender, all models were stratified by gender, which also accounted for the majority of potential clustering within households. The interactions between gender, household wealth and social participation were also tested to further justify the stratified analyses. We investigated the relationships between household wealth and loneliness in multivariable models firstly controlling for age, education level, immigrant status and marital status as potential confounding variables. We then included the combined measure of social participation, which included the different types of activities and their frequency, and then examined the relationships by activity type. After this, we tested whether taking part in social activities modified the association between wealth and loneliness by combining the wealth and social participation variables. We examined the odds ratios associated with each category, using the lowest risk group as the reference (the wealthiest quintile and frequent social participation) (Knol and VanderWeele, 2012). We also tested statistical interactions between wealth and social participation variables, controlling for additional potential confounding variables associated with social participation and loneliness: household size, functional limitations and frequency of contact with children. The statistical significance of interaction terms was assessed using Wald tests.

We examined potential multicollinearity using the Variance Inflation Factor (VIF), but it was not considered to be a concern due to the relatively low VIF (mean of 1.14). McKelvey and Zavoina's R-squared for multilevel logistic regression was used to assess model fit (Windmeijer, 1995). Individuals with missing data for exposure and outcome variables were excluded (N=1,844, 5.83%), apart from household wealth which was multiply imputed by the SHARE team. Weights were not used in the analyses as we used a subsample of SHARE and did not aim to produce nationally representative prevalence estimates. Analyses were performed using Stata SE/14.1.

Results

Descriptive statistics

A total of 29,795 (55.29% female) individuals were included in the analysis (Table 1). As expected, loneliness was higher among women (21.97%), compared with men (15.31%) (Table 2). This is similar to the overall levels of loneliness reported in a previous study, with men ranging from 14.1% to 16.3% and women from 21.3% to 23.9%, in 2001 and 2010, respectively (Pikhartova et al., 2014). In the sample, 21.64% (N=2883) of men and 20.66% (N=3404) of women reported frequent social

participation. Among women, levels of loneliness increased with decreased household wealth. Women in the least wealthy quintile experienced markedly higher levels of loneliness (28.27%) compared with the wealthiest quintile (18.72%) and there was a gradient of increasing loneliness with decreased wealth. Among men, the prevalence of loneliness was also distinctly higher among the least wealthy, at 22.08%, and reduced with increasing wealth. However, loneliness in the wealthiest quintile (13.37%) was slightly higher than the prevalence of loneliness in quintile four (13.17%). The percentage difference in the prevalence of loneliness between the least and wealthiest quintiles was 8.71% among men and 9.55% among women. The prevalence of frequent social participation displayed a distinct social gradient and was around 10% more common in the wealthiest quintile compared to the least wealthy. Frequent participation in sport, social, or other clubs was most commonly reported among men and women, and participation in training or educational courses was the least frequent activity among men, whereas among women it was political or community organisations (Appendix A). Generally, there was a dose-response relationship between increased household wealth and the prevalence of all forms of social participation.

Multilevel results

In adjusted analyses, as household wealth increased, the risk of experiencing loneliness decreased (Table 3 Model 1). The odds ratio for men in the wealthiest quintile was 0.63 (95% CI: 0.53 to 0.74) and for women it was 0.73 (95% CI: 0.65 to 0.83), compared to the least wealthy quintile. Frequent social participation was related to a lower risk of loneliness among both men (OR=0.83, 95% CI: 0.73 to 0.95) and women (OR=0.70, 95% CI: 0.63 to 0.78) (Table 3 Model 2). The addition of the social participation variable made little difference to the association between wealth and loneliness, suggesting it was not an important mediating variable. Statistically significant interaction terms were found between gender, household wealth and social participation, which demonstrated that differences in the risk of loneliness by gender and wealth were more pronounced among those who did not frequently take part in formal social activities (Appendix B). The different types of social participation exhibited varying associations with loneliness (Appendix C). Individuals who frequently participated in charity or voluntary work, or sport, social or other clubs, had lower odds of reporting loneliness, compared to those who did not. Taking part in political and community organisations was also related to a lower risk of loneliness, but the association was weaker compared to the other two types of activities. Frequent participation in education or training courses was not associated with loneliness among men or women, but fewer individuals reported these activities.

There was evidence to suggest that social participation modified the association between household wealth and loneliness (Figure 1), with effect modification more apparent among men. For example, the odds ratio for loneliness among those who did not frequently participate in formal social activities in the least wealthy quintile was 1.91 (95% CI: 1.44 to 2.51) among men and 1.71 (95% CI: 1.38 to

2.13) among women, compared to those who reported frequent social participation and were in the wealthiest quintile (Table 4 Model 1). Whereas, the odds ratio among those in the wealthiest quintile who did not participate in frequent formal social activities was only 1.14 (95% CI: 0.86 to 1.51) among men and 1.26 (95% CI: 1.01 to 1.59) among women. A statistically significant interaction between household wealth and social participation was also evident among men (p=0.035) (Table 4 Model 2), but not women. This suggested that men in the least wealthy quintile who did not frequently participate in social activities had greater risk of loneliness compared to those reporting frequent social participation. Overall, according to the R-squared values, the variables explained loneliness to a greater extent among men, compared with women.

Discussion

Our results highlight the need to consider social inequalities in loneliness as a public health issue among older people in Europe, in addition to preventing overall levels of loneliness. We found the least wealthy older people experience greatest risk of loneliness and they are also less likely to participate in formal social activities compared to wealthier individuals. Frequent participation in formal social activities also moderated the relationship between household wealth and loneliness, suggesting that for socially-disadvantaged groups, taking part in external activities may act as a buffer against experiencing loneliness, particularly among men. Examination of the different types of social participation revealed that for both genders, being involved in sports and social clubs, or volunteer/charity work was most strongly related to the reduced likelihood of loneliness, compared to other social activities. These activities were also more frequently reported by participants, compared to other activities, such as educational courses or involvement in a political or community organisation.

In our Europe-wide study, the least advantaged groups experienced higher levels of loneliness and participated less in social activities, concurring with previous research (Bosma et al., 2015; de Jong Gierveld et al., 2015; Hansen and Slagsvold, 2015; McMunn et al., 2009). This suggests that a lack of financial resources may constrain some individuals from fully participating in society, which may lead to loneliness and social isolation among those who are already at risk via a number of different pathways, including poor health and widowhood. However, research comparing the association between wealth and loneliness across nine countries of the Former Soviet Union found that wealth was only related in three of the countries studied (Stickley et al., 2013). This suggests that wider political or cultural factors may be involved, similar to other outcomes, such as wellbeing and quality of life (Niedzwiedz et al., 2015). Our finding that frequent participation in social activities may protect against loneliness among those with less wealth could be due to the associated social contact, development of social networks, and sense of identity that these activities help to support (Milligan et al., 2015). The stronger evidence found for men may be due to their generally smaller support

networks as compared with women (Dykstra and Fokkema, 2007), and women may benefit more from interactions with family. Participation in sports clubs has been shown to enable men to exchange life experiences with others who share similar interests and characteristics (Bunn et al., 2016), which could plausibly reduce feelings of loneliness and be related to fewer depressive symptoms, via the benefits of physical activity. The weaker association between participation in political and community organisations and loneliness is consistent with a recent study that found involvement in these activities was associated with an increase in depressive symptoms four years later, which the authors suggested may be due to the high effort and low reward incurred (Croezen et al., 2015).

Strengths and limitations

Our paper has a number of strengths including the use of cross-nationally comparable data and a validated measure of loneliness. Previous studies have often not considered inequalities by wealth, despite it being a more appropriate indicator of socioeconomic position among older adults, compared to indicators such as educational qualifications (Demakakos et al., 2015), and better reflective of life course economic circumstances. We also explored gender differences, which previous studies have often neglected (Dahlberg et al., 2015). However, the limitations should be acknowledged. The cross-sectional study design means we cannot make causal inferences; longitudinal evidence is needed to establish whether a causal relationship is likely. The sample analysed cannot be considered representative of all older adults, as institutionalised populations were not included. We were also limited by the survey questionnaire items, in which information about specific participation in religious organisations was not available. In addition, household wealth was self-reported and may be subject to reporting bias.

Conclusion

Loneliness is increasingly prioritised as a public health issue and interventions are being developed to prevent and minimise it (Cohen-Mansfield and Perach, 2015), including many designed to increase social participation. It is important to assess the impact of interventions on different socioeconomic groups and ensure the least advantaged groups have equal opportunity to participate. Increasing social participation among the least advantaged groups could help narrow social inequalities in loneliness, which may have related benefits in terms of narrowing inequalities in other health and wellbeing outcomes. However, longitudinal research examining changes in social participation and loneliness is needed to help establish whether this may be a causal effect. Research that delves further into the mechanisms through which specific types of social participation may decrease loneliness is required and additional work is needed to examine the different factors that help to explain loneliness among women, which appears to be more complex than compared with men. Further, it is important to recognise and address the barriers that older people may face to increasing their social participation, particularly among disadvantaged groups.

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Conflicts of interest: none

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Table 1: Descriptive statistics for the sample of older adults participating in SHARE during 2013

	Male		Female	
Age group	**N**	**%**	**N**	**%**
65-69	4231	31.76	5084	30.86
70-74	3607	27.08	4287	26.02
75-79	2727	20.47	3305	20.06
80-84	1772	13.30	2321	14.09
85+	985	7.39	1476	8.96
Born in country				
Yes	12075	90.64	14915	90.54
No	1247	9.36	1558	9.46
Household wealth				
1 (Least wealthy)	2142	16.08	3658	22.21
2	2723	20.44	3256	19.77
3	2985	22.41	3300	20.03
4	2884	21.65	3321	20.16
5 (Most wealthy)	2588	19.43	2938	17.84
Education level				
Low	5548	41.65	8679	52.69
Medium	4733	35.53	5236	31.79
High	3041	22.83	2558	15.53
Household size				
1	2131	16.00	6112	37.10
2	9686	72.71	9032	54.83
3 or more	1505	11.30	1329	8.07
Marital status				
Married	10679	80.16	9133	55.44
Never married	544	4.08	678	4.12
Divorced/separated	819	6.15	1426	8.66
Widowed	1280	9.61	5236	31.79
Functional ability				
Not limited	6811	51.13	7231	43.90
Limited	6511	48.87	9242	56.10
Contact with children				
No children	1223	9.18	1540	9.35
Daily	5664	42.52	7574	45.98
Several times per week	3790	28.45	4503	27.34
About once per week	1663	12.48	1941	11.78
Less than weekly	982	7.37	915	5.55
Overall social participation				
Infrequent	10439	78.36	13069	79.34
Frequent	2883	21.64	3404	20.66
Participation in voluntary/charity work				

Infrequent	11951	89.71	14902	90.46
Frequent	1371	10.29	1571	9.54
Participation in education/training course				
Infrequent	13040	97.88	15867	96.32
Frequent	282	2.12	606	3.68
Participation in sport, social or other club				
Infrequent	10593	79.52	13420	81.47
Frequent	2729	20.48	3053	18.53
Participation in political or community organisation				
Infrequent	12988	97.49	16257	98.69
Frequent	334	2.51	216	1.31
Total	13322	44.71	16473	55.29

N=number of individuals

Table 2: Prevalence of loneliness and social particiatption by household wealth quintile for older adults participating in SHARE during 2013

Wealth quintile	Loneliness (%)	Loneliness (N)	Frequent social participation (%)	Frequent social participation (N)	Total (N)
	Men				
1 (least wealthy)	22.08	473	16.06	344	2,142
2	15.35	418	19.35	527	2,723
3	14.14	422	22.18	662	2,985
4	13.17	380	23.99	692	2,884
5 (most wealthy)	13.37	346	25.43	658	2,588
Total	*15.31*	*2,039*	*21.64*	*2,883*	*13,322*
	Women				
1 (least wealthy)	28.27	1,034	15.64	572	3,658
2	21.87	712	18.86	614	3,256
3	20.15	665	20.70	683	3,300
4	19.81	658	22.64	752	3,321
5 (most wealthy)	18.72	550	26.65	783	2,938
Total	*21.97*	*3,619*	*20.66*	*3,404*	*16,473*

N=number of individuals; %=percentage

Loneliness defined by being in the top quartile of the R-UCLA scale

Table 3: Results from multilevel logistic regression models for loneliness among older adults participating in SHARE during 2013

	Men		**Women**	
	Model 1	**Model 2**	**Model 1**	**Model 2**
	OR [95% CI]	**OR [95% CI]**	**OR [95% CI]**	**OR [95% CI]**
Education level				
Low (ref)	-	-	-	-
Medium	0.96 [0.85,1.09]	0.97 [0.85,1.10]	0.77*** [0.70,0.85]	0.79*** [0.71,0.86]
High	0.91 [0.79,1.05]	0.93 [0.80,1.07]	0.82** [0.72,0.92]	0.84** [0.75,0.95]
Wealth (quintile)				
1 (ref)	-	-	-	-
2	0.75*** [0.64,0.87]	0.75*** [0.64,0.87]	0.85** [0.76,0.95]	0.86** [0.76,0.96]
3	0.70*** [0.60,0.82]	0.71*** [0.61,0.82]	0.81*** [0.72,0.91]	0.82*** [0.73,0.92]
4	0.65*** [0.55,0.76]	0.65*** [0.56,0.76]	0.79*** [0.70,0.89]	0.80*** [0.71,0.90]
5	0.63*** [0.53,0.74]	0.63*** [0.54,0.75]	0.73*** [0.65,0.83]	0.75*** [0.66,0.85]
Age group				
65-69 (ref)	-	-	-	-
70-74	1.12 [0.97,1.28]	1.11 [0.97,1.28]	1.10 [0.98,1.22]	1.09 [0.98,1.22]
75-79	1.41*** [1.23,1.63]	1.40*** [1.22,1.62]	1.26*** [1.12,1.41]	1.24*** [1.10,1.39]

80-84	1.62*** [1.39,1.90]	1.60*** [1.36,1.87]	1.57*** [1.39,1.78]	1.53*** [1.35,1.73]
85+	2.05*** [1.71,2.46]	2.00*** [1.66,2.40]	1.66*** [1.44,1.92]	1.60*** [1.39,1.84]
Immigrant status				
Born in country of residence (ref)	-	-	-	-
Born outside country of residence	1.30** [1.11,1.53]	1.30** [1.10,1.53]	1.28*** [1.12,1.45]	1.27*** [1.12,1.45]
Marital status				
Married/civil partnership (ref)	-	-	-	-
Never married	2.43*** [1.97,2.99]	2.40*** [1.95,2.96]	1.88*** [1.56,2.26]	1.88*** [1.57,2.27]
Divorced/separated	2.29*** [1.92,2.73]	2.28*** [1.91,2.73]	1.95*** [1.70,2.23]	1.95*** [1.71,2.24]
Widowed	3.27*** [2.86,3.75]	3.29*** [2.87,3.76]	2.01*** [1.84,2.20]	2.02*** [1.85,2.21]
Frequency of social participation				
Infrequent (ref)	-	-	-	-
Frequent	-	0.83** [0.73,0.95]	-	0.70*** [0.63,0.78]
R-squared	0.12	0.12	0.06	0.07
N	13322	13322	16473	16473

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; CI= confidence interval; N=number of individuals; OR=odds ratio

Model 1= education level, household wealth quintile, age group, immigrant status, marital status

Model 2= Model 1 + frequency of social participation

Table 4: Results from multilevel logistic regression models for loneliness examining effect modification and the interaction between social participation and household wealth among older adults participating in SHARE during 2013

	Men		Women	
	Model 1	**Model 2**	**Model 1**	**Model 2**
	OR [95% CI]	**OR [95% CI]**	**OR [95% CI]**	**OR [95% CI]**
Education level				
Low (ref)	-	-	-	-
Medium	0.97 [0.86,1.10]	1.01 [0.89,1.14]	0.79*** [0.71,0.86]	0.78*** [0.70,0.85]
High	0.93 [0.80,1.07]	1.00 [0.87,1.16]	0.84** [0.75,0.95]	0.85** [0.75,0.96]
Wealth (quintile)				
1 (ref)	-	-	-	-
2	-	0.74*** [0.62,0.87]	-	0.88* [0.78,1.00]
3	-	0.69*** [0.58,0.81]	-	0.84** [0.74,0.96]
4	-	0.62*** [0.52,0.74]	-	0.85* [0.74,0.97]
5	-	0.61*** [0.51,0.74]	-	0.77*** [0.67,0.88]
Age group				
65-69 (ref)	-	-	-	-
70-74	1.12 [0.97,1.28]	1.06 [0.92,1.22]	1.09 [0.98,1.21]	1.00 [0.90,1.12]
75-79	1.40*** [1.22,1.62]	1.30*** [1.12,1.50]	1.23*** [1.10,1.38]	1.09 [0.97,1.22]
80-84	1.60*** [1.37,1.87]	1.37*** [1.17,1.61]	1.52*** [1.35,1.73]	1.26*** [1.11,1.43]
85+	2.01*** [1.67,2.42]	1.57*** [1.30,1.90]	1.60*** [1.38,1.84]	1.24** [1.07,1.43]
Immigrant status				
Born in country of residence (ref)	-	-	-	-
Born outside country of residence	1.30** [1.11,1.53]	1.35*** [1.14,1.59]	1.27*** [1.12,1.45]	1.26*** [1.10,1.43]
Marital status				
Married/civil partnership (ref)	-	-	-	-
Never married	2.41*** [1.95,2.97]	0.83 [0.62,1.12]	1.88*** [1.56,2.27]	1.11 [0.89,1.40]
Divorced/separated	2.30*** [1.92,2.74]	1.14 [0.91,1.44]	1.96*** [1.71,2.24]	1.44*** [1.22,1.70]
Widowed	3.30*** [2.88,3.78]	1.61*** [1.31,1.98]	2.03*** [1.85,2.21]	1.59*** [1.40,1.81]
Frequency of social participation				
Infrequent (ref)	-	-	-	-
Frequent	-	0.60** [0.43,0.84]	-	0.78* [0.63,0.98]
Wealth (quintile) and frequency of social participation				
Quintile 1 and frequent social	1.12 [0.76,1.67]	-	1.26 [0.95,1.68]	-

participation				
Quintile 2 and frequent social participation	1.08 [0.75,1.55]	-	0.99 [0.73,1.33]	-
Quintile 3 and frequent social participation	1.11 [0.79,1.57]	-	0.97 [0.72,1.30]	-
Quintile 4 and frequent social participation	1.16 [0.83,1.63]	-	0.86 [0.65,1.16]	-
Quintile 5 and frequent social participation (ref)	-	-	-	-
Quintile 1 and infrequent social participation	1.91*** [1.44,2.51]	-	1.71*** [1.38,2.13]	-
Quintile 2 and infrequent social participation	1.38* [1.04,1.82]	-	1.49*** [1.19,1.86]	-
Quintile 3 and infrequent social participation	1.27 [0.97,1.68]	-	1.41** [1.13,1.77]	-
Quintile 4 and infrequent social participation	1.14 [0.86,1.51]	-	1.41** [1.13,1.76]	-
Quintile 5 and infrequent social participation	1.14 [0.86,1.51]	-	1.26* [1.01,1.59]	-
Household size				
One (ref)	-	-	-	-
Two	-	0.39*** [0.32,0.47]	-	0.69*** [0.61,0.79]
Three or more	-	0.38*** [0.30,0.49]	-	0.77** [0.65,0.92]
Limitations in functioning				
Not limited (ref)	-	-	-	-
Limited	-	2.42*** [2.17,2.69]	-	2.22*** [2.03,2.41]
Frequency of contact with children				
No children (ref)	-	-	-	-
Daily	-	0.64*** [0.53,0.78]	-	0.59*** [0.51,0.68]
Several times per week	-	0.60*** [0.49,0.74]	-	0.71*** [0.61,0.82]
About once a week	-	0.67*** [0.53,0.84]	-	0.89 [0.75,1.06]
Less than weekly	-	0.82 [0.65,1.05]	-	1.14 [0.94,1.39]
Interactions[1]				
Quintile 2 # frequent social participation[1]	-	1.45 [0.93,2.26]	-	0.93 [0.67,1.28]
Quintile 3 # frequent social participation[1]	-	1.65* [1.07,2.52]	-	0.92 [0.67,1.28]
Quintile 4 # frequent social participation[1]	-	1.98** [1.29,3.04]	-	0.85 [0.62,1.18]

Quintile 5 # frequent social participation	-	1.57* [1.01,2.43]	-	1.08 [0.78,1.48]
R-squared	0.12	0.19	0.07	0.12
N	13322	13322	16473	16473

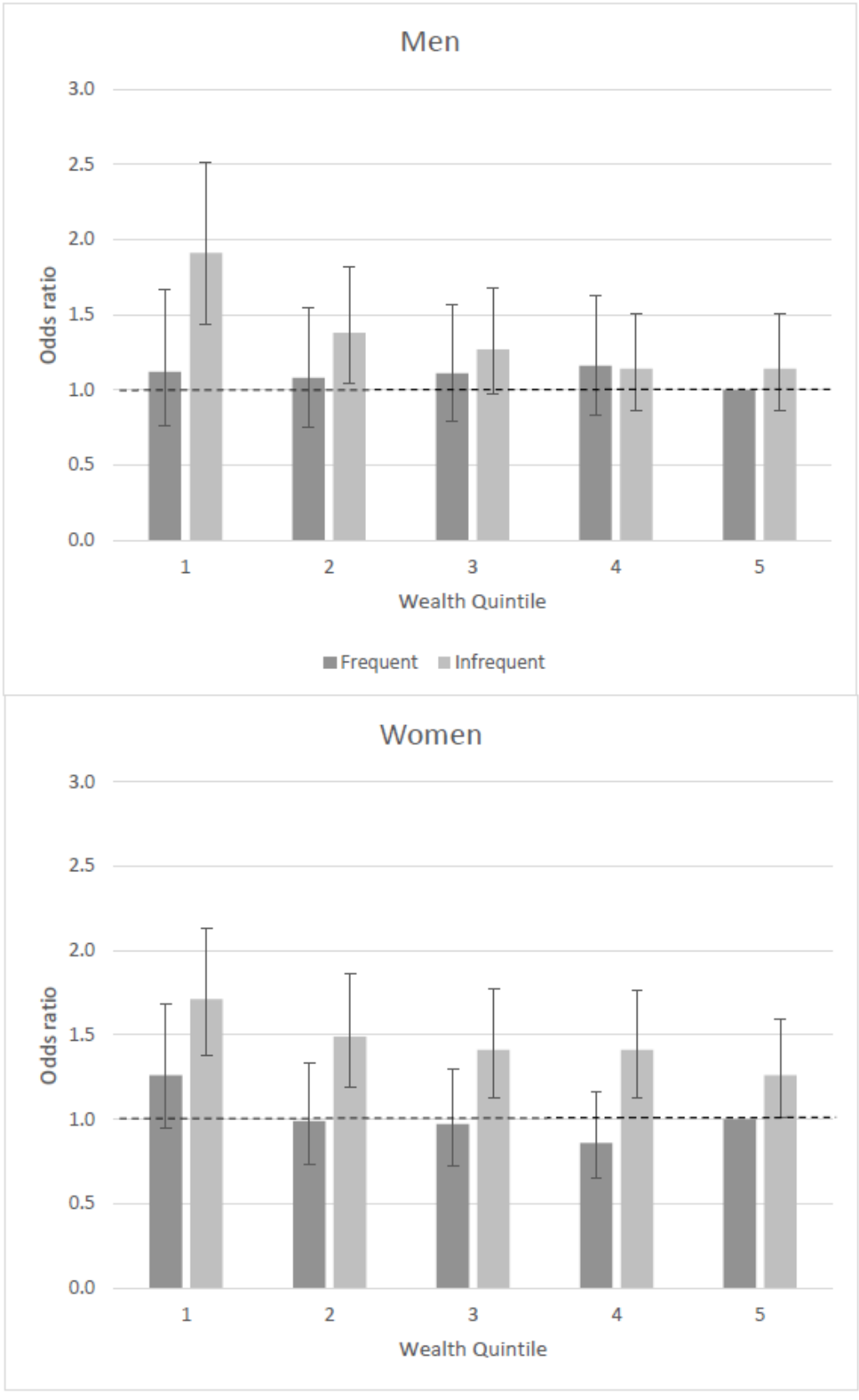
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; CI=confidence interval; N=number of individuals; OR=odds ratio; # interaction

[1] Reference category is household wealth quintile 1 and infrequent social participation

Model 1 includes education level, age group, immigrant status, marital status and household wealth/social participation variables

Model 2 includes education level, age group, immigrant status, marital status, household size, limitations in functioning, frequency of contact with children and the interaction between household wealth and social participation variables (including the main effects of each)

Figure 1: Odds ratios and 95% confidence intervals for loneliness by household wealth quintile and frequency of social participation dervied from multilevel logistic regression models adjusted for age group, education level, immigrant status and marital status



Supplementary Material

Appendix A: Prevalence of different types of social participation by household wealth quintile among older adults participating in SHARE during 2013

Quintile	Voluntary/ charity work (N)	%	Education/ training (N)	%	Sport/ social/ other club (N)	%	Political/ community organisations (N)	%	Total (N)
Men									
1 (least wealthy)	169	7.89	26	1.21	300	14.01	40	1.87	2,142
2	260	9.55	38	1.40	460	16.89	56	2.06	2,723
3	282	9.45	54	1.81	644	21.57	65	2.18	2,985
4	312	10.82	69	2.39	666	23.09	84	2.91	2,884
5 (most wealthy)	348	13.45	95	3.67	659	25.46	89	3.44	2,588
Total	*1,371*	*10.29*	*282*	*2.12*	*2,729*	*20.48*	*334*	*2.51*	*13,322*
Women									
1 (least wealthy)	277	7.57	82	2.24	462	12.63	34	0.93	3,658
2	288	8.85	90	2.76	523	16.06	39	1.20	3,256
3	295	8.94	119	3.61	606	18.36	47	1.42	3,300
4	353	10.63	136	4.10	710	21.38	41	1.23	3,321
5 (most wealthy)	358	12.19	179	6.09	752	25.60	55	1.87	2,938
Total	*1,571*	*9.54*	*606*	*3.68*	*3,053*	*18.53*	*216*	*1.31*	*16,473*

N=number of individuals

Appendix B: Results from multilevel logistic regression models for loneliness examining the interaction between gender, household wealth and social particiaption among older adults participating in SHARE during 2013

	OR [95% CI]
Education level	
Low (ref)	-
Medium	0.85*** [0.79,0.92]
High	0.87** [0.80,0.96]
Household wealth (quintile)	
1 (ref)	-
2	0.70*** [0.60,0.83]
3	0.65*** [0.55,0.76]
4	0.59*** [0.49,0.69]
5	0.60*** [0.51,0.72]
Frequency of social participation	
Infrequent	-
Frequent	0.60** [0.44,0.83]
Interaction between household wealth and frequency of social participation (ref is quintile 1 and infrequent social participation)	
Quintile 2 # frequent social participation	1.32 [0.86,2.03]
Quintile 3 # frequent social participation	1.48 [0.98,2.23]
Quintile 4 # frequent social participation	1.69* [1.12,2.55]
Quintile 5 # frequent social participation	1.44 [0.94,2.20]
Gender	
Male	-
Female	1.00 [0.87,1.15]
Interaction between household wealth and gender (ref is quintile 1 and male)	
Quintile 2 # female	1.28* [1.04,1.56]
Quintile 3 # female	1.32** [1.08,1.63]
Quintile 4 # female	1.46*** [1.18,1.80]
Quintile 5 # female	1.26* [1.01,1.56]
Interaction between gender and frequency of social participation (ref is infrequent social participation and male)	
Frequent social participation # female	1.19 [0.81,1.75]
Interaction between household wealth, frequency of social participation and gender (ref is quintile 1, infrequent social participation and male)	
Quintile 2 # frequent social participation # female	0.68

	[0.39,1.16]
Quintile 3 # frequent social participation # female	0.63 [0.38,1.07]
Quintile 4 # frequent social participation # female	0.50** [0.30,0.84]
Quintile 5 # frequent social participation # female	0.76 [0.45,1.28]
Age group	
65-69 (ref)	-
70-74	1.09* [1.00,1.19]
75-79	1.29*** [1.18,1.41]
80-84	1.54*** [1.39,1.69]
85+	1.71*** [1.53,1.92]
Immigrant status	
Born in country of residence (ref)	-
Born outside country of residence	1.29*** [1.16,1.42]
Marital status	
Married/civil partnership (ref)	-
Never married	2.08*** [1.81,2.39]
Divorced/separated	2.09*** [1.88,2.33]
Widowed	2.31*** [2.14,2.49]
R-squared	0.09
N	29795

CI=confidence interval; N=number of individuals; OR=odds ratio; #=interaction
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix C: Results from multilevel logistic regression models for loneliness according to type of social participation among older adults participating in SHARE during 2013

	Men				Women			
	Model 1 Charity/voluntary work	**Model 2 Education/training course**	**Model 3 Sport/social/other club**	**Model 4 Political/community organisation**	**Model 1 Charity/voluntary work**	**Model 2 Education/training course**	**Model 3 Sport/social/other club**	**Model 4 Political/community organisation**
	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]
Education level								
Low (ref)	-	-	-	-	-	-	-	-
Medium	0.96 [0.85,1.09]	0.96 [0.84,1.08]	0.97 [0.86,1.10]	0.96 [0.85,1.09]	0.78*** [0.71,0.86]	0.78*** [0.71,0.85]	0.79*** [0.72,0.87]	0.77*** [0.70,0.85]
High	0.93 [0.81,1.07]	0.91 [0.78,1.05]	0.93 [0.81,1.08]	0.93 [0.80,1.07]	0.84** [0.74,0.95]	0.83** [0.73,0.93]	0.85** [0.75,0.96]	0.82** [0.73,0.93]
Wealth (quintile)								
1 (ref)	-	-	-	-	-	-	-	-
2	0.75*** [0.64,0.87]	0.75*** [0.64,0.87]	0.75*** [0.64,0.87]	0.75*** [0.64,0.87]	0.85** [0.76,0.96]	0.85** [0.76,0.95]	0.86** [0.76,0.96]	0.85** [0.76,0.95]
3	0.70*** [0.60,0.82]	0.70*** [0.60,0.82]	0.71*** [0.61,0.83]	0.70*** [0.60,0.82]	0.81*** [0.72,0.91]	0.81*** [0.72,0.91]	0.82*** [0.73,0.92]	0.81*** [0.72,0.91]
4	0.65*** [0.55,0.76]	0.65*** [0.55,0.76]	0.66*** [0.56,0.77]	0.65*** [0.55,0.76]	0.79*** [0.70,0.89]	0.79*** [0.70,0.89]	0.81*** [0.72,0.91]	0.79*** [0.70,0.89]
5	0.63*** [0.54,0.74]	0.63*** [0.53,0.74]	0.64*** [0.54,0.75]	0.63*** [0.53,0.74]	0.74*** [0.65,0.84]	0.74*** [0.65,0.83]	0.76*** [0.67,0.86]	0.74*** [0.65,0.83]
Age group								
65-69 (ref)	-	-	-	-	-	-	-	-
70-74	1.11 [0.97,1.28]	1.12 [0.97,1.28]	1.11 [0.97,1.28]	1.11 [0.97,1.28]	1.09 [0.98,1.22]	1.10 [0.98,1.22]	1.09 [0.98,1.21]	1.10 [0.98,1.22]

75-79	1.40*** [1.22,1.62]	1.41*** [1.23,1.63]	1.39*** [1.21,1.61]	1.41*** [1.22,1.62]	1.24*** [1.11,1.39]	1.25*** [1.12,1.40]	1.23*** [1.10,1.38]	1.25*** [1.12,1.41]
80-84	1.60*** [1.36,1.87]	1.63*** [1.39,1.91]	1.58*** [1.35,1.86]	1.61*** [1.38,1.89]	1.54*** [1.36,1.74]	1.56*** [1.38,1.77]	1.52*** [1.34,1.72]	1.57*** [1.39,1.77]
85+	2.00*** [1.67,2.41]	2.06*** [1.71,2.47]	1.98*** [1.65,2.38]	2.03*** [1.69,2.44]	1.62*** [1.40,1.87]	1.66*** [1.44,1.91]	1.59*** [1.38,1.84]	1.66*** [1.44,1.91]
Immigrant status								
Born in country of residence (ref)	-	-	-	-	-	-	-	-
Born outside country of residence	1.30** [1.10,1.52]	1.30** [1.11,1.53]	1.30** [1.10,1.52]	1.30** [1.11,1.53]	1.27*** [1.12,1.45]	1.28*** [1.12,1.46]	1.27*** [1.12,1.45]	1.28*** [1.12,1.45]
Marital status								
Married/civil partnership (ref)	-	-	-	-	-	-	-	-
Never married	2.43*** [1.97,2.99]	2.43*** [1.97,2.99]	2.39*** [1.94,2.95]	2.42*** [1.96,2.99]	1.90*** [1.57,2.28]	1.88*** [1.56,2.26]	1.87*** [1.55,2.25]	1.88*** [1.56,2.26]
Divorced/separated	2.29*** [1.92,2.73]	2.29*** [1.92,2.73]	2.28*** [1.91,2.72]	2.30*** [1.93,2.74]	1.96*** [1.71,2.24]	1.95*** [1.70,2.23]	1.96*** [1.71,2.24]	1.95*** [1.70,2.23]
Widowed	3.27*** [2.85,3.75]	3.27*** [2.85,3.75]	3.29*** [2.87,3.77]	3.27*** [2.85,3.75]	2.02*** [1.85,2.21]	2.01*** [1.84,2.20]	2.02*** [1.85,2.21]	2.01*** [1.84,2.20]
Frequency of social participation								
Infrequent (ref)	-	-	-	-	-	-	-	-
Frequent	0.77** [0.64,0.93]	1.22 [0.88,1.70]	0.77*** [0.67,0.88]	0.61* [0.41,0.90]	0.69*** [0.59,0.80]	0.86 [0.68,1.07]	0.66*** [0.58,0.74]	0.61* [0.41,0.92]
R-squared	0.12	0.12	0.12	0.12	0.07	0.06	0.07	0.06
N	13322	13322	13322	13322	16473	16473	16473	16473

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; CI=confidence interval; N=number of individuals; OR=odds ratio

All models controlled for education level, household wealth quintile, age group, immigrant status, marital status

Model 1= the above control variables and frequency of participation in voluntary/charity work

Model 2= the above control variables and frequency of participation in education/training course

Model 3= the above control variables and frequency of participation in sport/social club

Model 4= the above control variables and frequency of participation in political/community organisations