

# Lonely places or lonely people? Investigating the relationship between loneliness and place of residence

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## Research article

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# Abstract

**Background:** Loneliness in later life is largely presented as a problem of the individual focusing upon antecedents of loneliness such as demographic or health factors. Research examining the role of the broader living environments is rarer. We examined the relationship between loneliness and three elements of the lived environment: geographical region, deprivation, and area classification (urban or rural).

**Methods:** Our sample consisted of 4,663 core members (44% males) aged 50+ (base wave mean age 65.5, S.D=.7.9) present in waves 3 (2008) and 7 (2014) of the English Longitudinal Study of Ageing (ELSA) which both included questions about individual-based and area-based loneliness. Loneliness was measured using two approaches- the three item University of California Los Angeles (UCLA) scale (ranging from 3 =not lonely to 9= lonely and using cut off at level 6+ marking loneliness) which assessed individual-based (self-reported) loneliness, and a novel self-rated evaluation by participants of how often they felt lonely in their area of residence (area-based; ranging from 1=often to 7=never, using cut off 4+). The lived environment was classified in three different ways: the Index of Multiple Deprivation (IMD), Government Office Regions (GOR), and as urban or rural. Covariates with established relationship with loneliness including demographic factors, social engagement and health, were included in the analyses.

**Results:** In wave 7, individual-based loneliness was reported by 18% and area-based loneliness by 25% of participants. There was limited congruence between measures: 68% participants reported no individual- or area-based loneliness and 9% reported loneliness in both areas. Adjusting for individual co-variates, a significant association was observed only for the association between area-based loneliness and deprivation measure area characteristic, with higher levels of loneliness in more deprived areas (OR=1.4 for highest quintile of deprivation). No other significant relationships were observed regarding other types of area characteristics.

**Conclusions:** Our results indicate that loneliness in older adults is higher in the most deprived areas independent of individual-level factors. In order to develop appropriate interventions further research is required to investigate how area-level factors combine with individual-level loneliness vulnerability measures to generate increased levels of loneliness in deprived areas.

## Background

### Loneliness

Loneliness as a concept is characterised as the gap between the aspirations and reality of an individual's quality, quantity, and /or mode of social relationships, or some combination of these elements which is 'unwanted' by the individual. These criteria serve to differentiate loneliness from other concepts, most notably social isolation and living alone [1,2]. Contemporary evidence from the UK reports that the highest prevalence loneliness, defined as those reporting they are often/always lonely, is observed in young adults aged 16 to 24 (10%) and that there is an age-related decline with 3 % of those aged 75+ reporting that they are 'often/always' lonely [3–5].

Loneliness is considered a public health issue because of the association with a range of negative outcomes including decreased well-being and quality of life [6], increased risk of deteriorating physical [7,8] and mental health [9,10], and increased mortality [11,12] alongside unhealthy behaviours [13,14,15] and health and social care services utilization [16]. Loneliness has attracted the attention of policy makers and service providers leading to extensive investment into loneliness interventions although evidence of effectiveness remains limited [19–22].

## Factors related to loneliness in later life

Victor and colleagues [23] and Victor and Sullivan [24] have argued that loneliness in later life is the product of the interaction of three sets of factors operating at macro- (societal), meso- (community/neighbourhood) and micro- (individual) level. Our current understanding of the antecedents of loneliness in later life emphasises micro-level factors, such as psychological (e.g. self-esteem), life-events (e.g. bereavement) or the onset of chronic illness, thereby positioning loneliness as a problem of the individual. Sullivan and Victor [25] suggest including the broader meso- and macro-level characteristics of older people lives, and their intersection with the micro-level factors, to generate a comprehensive understanding of the genesis of loneliness. Emblematic of the gap (regarding the importance of meso- and macro- level elements in factors underpinning loneliness in later life) is our limited understanding of the geography of loneliness and how area level factors are linked with loneliness.

At the macro-level, there is comparatively little research examining the distribution of loneliness geographically and considering how area based factors, such as deprivation or rural/urban typology are associated with loneliness in later life [19,26]. Age UK produced loneliness 'heat maps' for 32,844 neighbourhoods in England [27] focused upon helping target resources at areas most 'in need' but did not investigate how and why loneliness may vary between different types of geographical areas. This work replicates the 'loneliness maps' generated by Dorling [28]. In both cases these maps were based on the 'relative risk of loneliness' using factors associated with loneliness such as age, household size, marital status, and self-reported health status and not loneliness per-se.

At the meso- level, Nyquist and colleagues showed in the Finnish context that older individual's external meso-level context, such as neighbourhood quality and trust, demonstrate a relationship with loneliness [26]. They proposed that neighbourhood and community are important to older people as 'social resource' and act as bulwark against loneliness because they are not linked into employment-based networks and social resources. Neither of these approaches focus upon the specific types of geographical area such as urban, rural or deprived and the relationship with loneliness. We identified three types of studies that focus upon loneliness and area: descriptions of loneliness in deprived or rural areas; comparisons of loneliness in different types of areas (e.g. by levels of deprivation or between urban/rural areas), and investigations of deprivation or area typology as a risk factor for loneliness.

Descriptive studies focussing on older adults in the UK report high levels of loneliness in deprived areas. A study of 65 participants, mean age 71.6 (ranging 51–92), living in deprived areas of Manchester reported rates of severe loneliness of 16% and moderate loneliness of 49% using the 11 item de Jong Gierveld scale [29]. Using the same measure, Scharf and de Jong Gierveld reported a prevalence of loneliness of 13% for severe loneliness in 3 urban disadvantaged areas in Britain (London, Liverpool and Manchester) and 43% as moderately lonely for a sample of 497 participants aged 60–96 (mean age = 71.6) [17]. For rural areas in the UK, De Koning et al reported a prevalence of 9% for loneliness for those aged 65+ in 6 rural areas of England which approximates to the national norm [30] and is comparable to findings reported by Wenger and Burholt (2004) in a rural area of North Wales [31].

Studies drawing comparisons of individual-based loneliness between deprived and non-deprived areas or rural and urban areas for older adults are less numerous. At a national level, Menec and colleagues looked at the distribution of loneliness across Canada [32]. They used a single item from the CES-D which asks about loneliness in the last week and concluded that there was no difference in loneliness prevalence between rural (9%) and urban (10%) areas. Using a national sample of older adults being assessed for care services in New Zealand, Beer and colleagues report higher crude levels of loneliness in urban (21.6%) than rural (19.8%) areas and this difference remained significant after adjustment for socio-economic status, living alone, carer stress and relationship stress [34]. Havens and Hall (2004) compared loneliness among older (aged 72+) Manitobans and reported that, using a customised measure (derived from existing de Jong Gierveld scale and two single-item questions used elsewhere), 47% of rural and 43% of urban Manitobans were lonely [33]. A Polish study, reported by Tobiasz-Adamczyk, of 1,200 older adults aged 65+ concluded that there were no differences in loneliness between urban and rural areas using the 3 item UCLA scale (14.7% (urban) versus 15.8% (rural)) [35].

Evidence for deprivation or area typology (urban compared with rural) as a risk factor for loneliness in older adults is sparse. Cross-sectional data from Ireland reports crude mean UCLA loneliness scores that are the same for urban and rural areas (mean of 4.1, range 3–9) but that rurality played a role in the complex pathway to loneliness for older adults. [36]. Given the limited and inconsistent empirical evidence we sought to examine the relationship between loneliness and three distinct types of geographical area: deprivation, geographical region, and area typology (urban or rural) among older people living in England.

## Methods

### Dataset

We address our research question using the English Longitudinal Study of Ageing (ELSA): a nationally representative survey of approximately 10,000 people aged 50+ living in England. The survey is modelled on the well-established US Health and Retirement Survey (HRS; <http://hrsonline.isr.umich.edu>), and the initial ELSA cohort was based upon individuals who participated in the 1998, 1999, and 2001 waves of Health Survey for England (HSE; <https://www.ucl.ac.uk/hssrg/studies/hse>), and who were aged 50+ in

2002 when the first (baseline) wave of data were collected, including an administered survey and a self-completion questionnaire. The survey has taken place in a two-yearly intervals since then, with the most recently available data for analysis being from wave 8 (2016). The sample has been refreshed with HSE participants aged 50 years, to compensate for attrition, in waves 3, 4, 5 and 6. Ethical approval was granted from the National Research and Ethics Committee. Further details about the design, sampling and methodology of ELSA are available elsewhere (<http://www.elsa-project.ac.uk/documentation>).

## Measures

### Loneliness

We included two measures of loneliness in our analysis. Our main outcome variable is the three-item revised UCLA loneliness scale [37]. The three items included are: “How often do you feel you lack companionship?” “How often do you feel isolated from others?” and “How often do you feel left out?” Participants selected their response from 3 categories (hardly ever/never; some of the time; often) which are summed to give a total score ranging from 3–9. Scores are dichotomised, with scores 3–5 classified as not lonely and 6+ as lonely. Waves 3 and 7 of ELSA included a suite of questions focused on subjective neighbourhood evaluation [38], which done an evaluation of loneliness in the area in which participants lived. They were asked to evaluate, on 7-point Likert scale, whether they strongly agree to strongly disagree that ‘I often feel lonely living in this area’. This single item has not, to our knowledge, been used elsewhere to evaluate feelings of loneliness within an explicit spatial context. The scale was recoded to have the same directionality as the UCLA measure and dichotomised with a score of 4+ classified as feeling lonely. For both loneliness measures, dichotomisation was defined using the upper quartile classifying those who are lonely.

### Area based measures

ELSA data routinely includes details of the 9 administrative regions of England (see Supplementary file, figure 1). No finer grained data about the areas in which participants live are provided to assure participants of anonymity and confidentiality. Following a special data access request, National Centre for Social Research (NatCen; <http://natcen.ac.uk/>), the organisation that oversees such matters, provided us with a data set which included two area based measures (urban /rural classification; data about deprivation) which were linked to individuals via their individual study number. The Index of Multiple Deprivation (IMD) has been produced and validated by the Department of Communities and Local Government [39]. It is area-level measure available for 32,844 small areas in England and is based upon 7 domains of deprivation (Income; employment; education, skills and training; health deprivation and disability; crime; barriers to housing and services; and living environment) ([https://data.gov.uk/dataset/imd\\_2004](https://data.gov.uk/dataset/imd_2004)). Areas are ranked by score and, as there is no absolute value that differentiates deprived from non-deprived areas, analysis is usually based around quintiles with 1<sup>st</sup> quintile characterising the least deprived area and 5<sup>th</sup> quintile the most deprived one. The urban and rural area classification is produced by the Office for National Statistics (ONS) and areas are defined as Urban

(includes urban areas, towns and urban fringes) and Rural (village, Isolated dwellings/hamlets) based upon the size of the settlement and population density (<https://www.gov.uk/government/collections/rural-urban-classification>). Obtained geographical data were grouped (by provider) to reduce their sensitivity and categorised as following: urban, town and fringe, village, hamlets and isolated dwellings.

## Co-variates

The co-variates included in our analysis are a well-established predictors of loneliness including gender, marital/partnership status, social relationships (close relationships with 2+ family/friends and current participation in civic activities), employment status, health (self-rated health, depressive symptoms, activities of daily living and long-standing limiting illness). However, we did not include co-variates such as income that were included in the IMD deprivation measure.

## Analytic sample

Our analysis is based on 4,663 ELSA core members that satisfied two criteria: (a) they participated in waves 3 and 7 (which included both the UCLA scale and the area based loneliness measure) and (b) they had not moved between waves 6 and 7 as our area data was only available for wave 6. This group represented 95% of those included in both waves 3 and 7.

## Analysis plan

Our analysis had two phases. First, we used descriptive statistics and bivariate regression analysis to profile our analytic sample and to evaluate the crude association between independent variables and dependent variables separately. We then undertook a series of multivariable regression analyses to evaluate the role of area characteristics in reported loneliness using the complete case sample as we considered it inappropriate to use imputation for missing socio-demographic data. Our three regression models were as follows: model A, loneliness measured by the 3-item UCLA scale was adjusted for age and gender; model B, we further adjusted for social network characteristics (marital status, evaluation of close feelings to at least two members of the family or friends, civic participation, and job market participation); in model C, health status characteristics (depressive symptoms, long-standing limiting illness, self-rated health, and difficulties with activities of daily living) were further adjusted for. We repeated this analysis for the area-based loneliness measure. Analyses were carried using STATA MP Version 13.0 with p-value <0.05 signifying statistical significance.

## Results

### Characteristics of sample

Table 1 describes the characteristics of our wave 7 sample. The mean age of participants was 73 years (S. D. = 7.1), 56% were females and 22% participants were widowed. The majority, 84%, were retired, had two and more close relationships with family/other relatives/friends/neighbours or colleagues (88%), and were actively participating in society (74%). In terms of health status, 70% rated their health as good, 20% reported depressive symptoms, and 40% stated that they had a longstanding (12 months or longer) illness that limited their daily activities. England is a predominately urban society and most ELSA participants lived in areas classified as urban (72.6%), and 11.2% lived in most deprived areas and 26% in lowest deprivation quintile (for cross-tabulation see Supplementary file, table 7). In terms of government administrative regions, 17% were resident in the South East and all other regions had around 10% of ELSA participants. Compared to the original wave 7 data (not presented in the table), our analytic sample is older (mean age of 72 vs 67), has significantly more widows (22% v 15%), the retired (84% v 63%), and has higher levels of longstanding illness. These differences reflect the impact of the ELSA sample refreshment strategy where new participants aged 50 were added (in waves 3,4,5, and 6) [40] and are reported elsewhere [41]. Key differences between sample waves 3 and 7 reflect the eight years gap within the same sample and include the increased mean age of the wave 7 participants (72.8 compared to 65.5); higher levels of widowhood (22% compared with 15%); increased number of retired (84% vs 58%) and higher levels of reported longstanding limiting illness (40% vs 31%) (see Supplementary file, table 1 for a comparison of waves 3 and 7). Comparison with those who did not take part in our waves of interest (dropped out or were added as a sample boost in later waves and therefore were not eligible for our analysis) shows that they were significantly younger, less likely to be widowed, had better health (self-rated, difficulties with activities of daily living and long-standing limiting illness) and greater access to people who could provide help/advice. No differences between the two groups (those who remain in the study and those who dropped-out) were observed for presence of depressive symptoms or both individual-based and area-based loneliness (see Supplementary file, table 2).

## **Loneliness and area: bivariate analysis**

Overall 18% in wave 7 scored six or more on individual-based loneliness scale (the UCLA scale; lonely people), 25% reported that they experienced area-based loneliness (lonely places). These prevalence rates were stable across both waves of data collection. The degree of agreement between our two measures of loneliness varied. In wave 7, 67.7% of those who did not report loneliness associated with area also did not report loneliness measured by UCLA scale. On the other hand, only approximately 9% of those reporting they were lonely in their area were classed as lonely on the UCLA scale (Supplementary file, table 6 a,b).

Crude loneliness prevalence rates described in Table 1 are not suggestive of a relationship between our three area characteristics. Supplementary file, table 3 and 4 show a consistent trend (for both measures of loneliness at both time points) to demonstrate a significant statistical relationship with all used geographical characteristics. Those living in the areas characterised by the highest level of deprivation are approximately twice as likely to report experiencing both type of loneliness compared with those

residents in the least deprived areas. No significant relations were observed with urban/rural characteristic of area or on geographical region level.

Using bivariate regression analyses there was consistent relationship with gender, marital status, social relationships and health for both measures and time points (Supplementary file, table 3 and 4). This suggests our sample is robust as these trends are reflective of accepted relationships between individual factors and loneliness.

We have tested gender as potential effect modifier for the association between measure of characteristic of the area and loneliness, but we did not find statistically significant evidence of such effect modification for individual loneliness (p-value = 0.431), neither for area-based loneliness (p-value = 0.439), hence we present our results adjusted for gender, rather than stratified.

## **Loneliness and area: multivariable analysis**

To test if the relationships between loneliness and deprivation observed in our bivariate analysis was simply an artefact of the socio-demographic profile of these areas we undertook multivariable analysis. Three multivariable models (A,B, and C) were developed. We adjusted initially for age and gender (Model A), social networks (Model B), and health status (Model C; Tables 2 and 3). For the individual-based loneliness, model A suggests a relationship between loneliness and area deprivation status, but this relationship loses significance once social engagement and health status is included in the model. For the area-based loneliness in the fully adjusted model (C), the relationship between loneliness measure and area deprivation was attenuated but remained significant. Participants living in the most deprived areas (bottom quintile) were by 40% more likely to report experiencing area-based loneliness compared with their counterparts in the least deprived area independent of differences in socio-demographic profile, social engagement and health status (OR = 1.42, 95% CI = 1.05–1.91. p-value = 0.021). Mutual adjusting for individual-based loneliness (not presented in table) showed very similar results (OR = 1.40, 95%CI = 1.01–1.93, p-value = 0.04) suggesting that area characteristics has independent influence on area-based loneliness compare to individual-based characteristics.

## **Discussion**

Research examining the antecedents of loneliness in older adults have predominantly focused upon individual characteristics. In our study we moved the focus away from individuals to the types of area in which they live as community/meso-level factors are neglected in loneliness research. We aimed to add to the existing evidence base by focusing upon the importance of place and the environment in which people live as a potential loneliness vulnerability factor. We investigated the importance of three geographical categories in relation to loneliness: area typology (urban/rural) geographical region, and the relative deprivation of areas. We used two measures of loneliness: the 3-item UCLA scale (measuring self-reported personal status), and a measure focused upon 'loneliness based on the area of residence'. We show that there are no relationships with region or area type or deprivation for the UCLA scale. However

there was, after adjustment for confounding factors, a statistically significant relationship between area-based loneliness and deprivation.

Existing research focused upon understanding the prevalence of and risk factors for loneliness and has largely concentrated on seeking explanation at the individual level. Sullivan et al (2016) have discussed many of the limitations of this approach to study loneliness including the presumption of shared understanding and the dynamic nature of the experience combined with the complexity and difficulty people may have in describing the experience of loneliness [25]. There is also an increasing acceptance that loneliness is not a static experience but one which may fluctuate during a day, a week or a year [42]. This also links to the increasing acceptance that the population characterised as 'lonely' is not homogeneous but includes those for whom loneliness is an enduring part of their life whilst for others loneliness may increase or decrease as they age.

We used two waves (3 and 7) of the English Longitudinal Study of Ageing (ELSA) to consider the relationship between loneliness and area as these included a specific question asking about loneliness in the area people resided. In terms of our loneliness outcome measures the revised UCLA scale is well established. The question on evaluating loneliness in the area where participants live was not and has not, to our knowledge, been used elsewhere. However, it does attempt to link the personal evaluation of loneliness to the area in which people live.

Our three geographical characteristics are all designed for administrative rather than research purposes. The measure of deprivation is designed for use as a means of targeting resources to areas in need. The urban-rural classification is limited in that it does not distinguish large conurbations such as London from smaller urban areas. Furthermore, our data show that England is a predominantly urban society and thus we may have had too few participants from rural areas making our study insufficiently powered to identify any differences. The third area characteristics was the geographical regions classification which gives only broad information from which part of England the participant comes but could help with distinguishing London area from the other regions. These caveats frame the confidence that we can have in our overall findings and highlight some issues to be addressed in further research.

Levels of loneliness, as assessed by our two measures, were broadly stable at 18% for the individual-based loneliness and 25% for the area-based one in both waves (Supplementary files, table 1). Inviting participants to evaluate loneliness in the context of the area where they lived generated a higher level of loneliness and this finding is, to our knowledge, novel in the literature. The congruence between the measures was good for those reporting that they were not lonely but was under 50% of those reporting loneliness (Supplementary file, table 6 a,b). This suggests that the area based measure is overlapping into a domain of loneliness not embraced by the social/emotional items included in more commonly used measures. Clearly the potential of the area-based measure and characteristics of those who report individual-based loneliness in one but not both measures merits further investigation. Our results differ in the level of prevalence not in results per se from those found by Scharf and colleagues in samples from England and from The Netherlands. These authors, along with Moorer and colleagues, suggested that

type of neighbourhood may be a more important factor influencing patterns of loneliness in England as compared with the Netherlands [17,18]. Our results seem to go along with this hypothesis. Once other factors were taken into account, loneliness was not associated with region or area classification in terms of urban/rural. However, there was a consistent relationship between area-based loneliness and high levels of deprivation that was independent of individual characteristics. This may reflect the features of the specific environment such as terrain or amenities, demographic characteristics, housing conditions, high crime rates, potential opportunities for engagement or issues of trust and neighbourliness and population turn-over. However as with the related concept of resilience there is a need to embrace the role of macro- (societal) and meso- (community/neighbourhood) factors in the emergence of vulnerability to loneliness. Further research with older people living in these types of areas is required to understand what is driving this relationship and what interventions might ameliorate it and to understand how micro-, meso-, and macro- level factors combine to protect or render older people vulnerable to loneliness.

## **The strength and limitations**

ELSA is the largest and most representative sample of older people in the community within the UK and, as such, is best UK-based available data set. Our analysis hence profits from having available longitudinal data for several thousand people. To our knowledge, the question on area-based loneliness was not used in other research. However, no guidance is given to respondents in terms of the size of the area to which the question refers. Nevertheless, there are limitations which relate to attrition, missing data and the exclusion of those older people living in care homes. The interpretation of results regarding IMD should be given with respect to the fact that we looked at information in wave 7 among participants who lived at the given addresses in year 2014 while the IMD data from 2004 were available for these addresses. It is likely that some changes in socioeconomic situation of the areas might have appeared.

## **Conclusions**

The results suggest that the area-based measure of loneliness is overlapping into a domain of individual-based loneliness and is not covered by the social/emotional items included in more commonly used measures. This research on English population using longitudinal data and area-based information (not often used in similar projects) found that those 50+ year old living in most deprived areas report the highest level of loneliness connected to area of living when all individual-level characteristics were taken into account. The study offers a new look at the living environment showing how older people experience ageing in the area they lived for longer time. The findings and following research focusing on the quality of ageing according to specific environment could help policy makers focussing on e.g. 'Healthy cities', 'Healthy ageing', or 'Ageing in place' to find population at risk and probably disentangle complex background of loneliness among older people living in more deprived areas, especially if they lived there for longer period of their life.

## **Declaration**

# Ethics approval and consent to participate

Participants gave full informed written consent to be part of the study. Ethical approval was obtained from the London Multi-Centre Research Ethics Committee. Presented research uses secondary data analysis.

## Consent to publish

Not applicable

## Availability of data and materials

The data that support the findings of this study are available from UK Data Archives and National Centre for Social Research (NatCen) but restrictions apply to the availability of some data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of NatCen.

## Competing interests

Authors declare no competing interests.

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## Authors' Contributions

J.Pikhartova wrote the first draft of the article and run all analyses. C.Victor critically reviewed the article. Both authors contributed to the idea, study design, and interpretation of data.

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## List Of Abbreviations

ELSA - English Longitudinal Study of Ageing

UCLA - University of California Los Angeles

HRS - Health and Retirement Survey

HSE - Health Survey for England

NatCen - National Centre for Social Research

IMD - Index of Multiple Deprivation

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## Tables

**Table 1. Descriptive table of analytical sample (wave 7 or specifically stated)**

		N (%) / mean (S.D)	Males	Females
Gender		4663	43.8%	56.2%
Age	<b>Wave 3</b>	65.5 (7.9)	65.1 (7.8)	65.8 (8.1)
	<b>Wave 7</b>	72.8 (7.1)	72.5 (7.0)	73.0 (7.2)
<b>SOCIAL NETWORK</b>				
Marital status	(Re)married/partnership	2903 (62.3)	52.4	47.6
	Always single	207 (4.4)	49.3	50.7
	Divorced/separated	510 (10.9)	36.3	63.7
	Widowed/partner died	1,043 (22.4)	22.4	77.6
	<i>Missing (N)</i>	<i>0</i>		
Has close relationship with 2+ family member/friend	Yes	3528 (87.5)	43.7	56.3
	No	506 (12.5)	45.3	54.7
	<i>Missing (N)</i>	<i>629</i>		
Active civic participation	Yes	2825 (74.2)	44.5	55.5
	No	983 (25.8)	43.6	56.4
	<i>Missing</i>	<i>855</i>		
Part of job market	Out of job market	3928 (84.4)	43.6	56.4
	Employed/semi-employed	530 (11.4)	57.4	42.6
	Looking after home/family	194 (4.2)	10.3	89.7
	<i>Missing</i>	<i>11</i>		
<b>HEALTH STATUS</b>				
Self-rated health	Excellent /very good/good	3125 (70.3)	44.5	55.5
	Fair/poor	1318 (29.7)	41.4	58.7
	<i>Missing</i>	<i>220</i>		
Depressive symptoms	No	3524 (80.4)	46.6	53.4
	3+ out of 8	860 (19.6)	31.5	68.5
	<i>Missing</i>	<i>279</i>		
Activities of daily living (ADL/IADL)	No difficulties	3433 (73.6)	45.0	55.0
	Difficulty with 1+	1228 (26.4)	40.4	59.6
	<i>Missing</i>	<i>2</i>		
Long-standing illness	No	1848 (39.7)	45.3	54.7
	Yes, not limiting	947 (20.3)	45.3	53.8
	Yes, limiting	1866 (40.0)	41.0	59.0
	<i>Missing</i>	<i>2</i>		
Reported loneliness (UCLA scale)	No	3208 (82.5)	46.0	54.0
	Yes (6+ out of 9)	683 (17.6)	34.4	65.6
	<i>Missing</i>	<i>772</i>		
Feel lonely living in this area	No	2993 (75.4)	47.3	52.7
	Yes (4+ out of 7)	957 (24.6)	34.7	65.3
	<i>Missing</i>	<i>773</i>		
<b>GEOGRAPHICAL CHARACTERISTICS (wave 6)</b>				
Index of Multiple Deprivation (IMD)	1 <sup>st</sup> quintile (least deprived)	1163 (26.0)	44.4	55.6
	2 <sup>nd</sup>	1181 (26.4)	46.7	54.3

	3 <sup>rd</sup>	899 (20.1)	43.5	56.5
	4 <sup>th</sup>	735 (16.4)	40.7	59.3
	5 <sup>th</sup>	500 (11.2)	42.6	57.4
	<i>Missing</i>	<i>185</i>		
Urban/rural distribution	Urban	3271 (72.6)	43.8	56.2
	Town/fringe	565 (12.5)	42.8	57.2
	Village	497 (11.0)	46.7	52.3
	Hamlets /isolated dwellings	174 (3.9)	42.5	57.4
	<i>Missing</i>	<i>156</i>		
Geographical regions	London	385 (8.6)	42.6	57.4
	North East	276 (6.1)	45.7	54.4
	North West	503 (11.2)	42.9	57.1
	Yorkshire and The Humber	487 (10.8)	42.1	56.9
	East Midlands	478 (10.6)	44.4	55.6
	West Midlands	494 (11.0)	44.5	55.5
	East of England	580 (12.9)	45.0	55.0
	South East	761 (16.9)	42.1	58.0
	South West	532 (11.8)	46.1	54.0
	<i>Missing</i>	<i>167</i>		

**Table 2. Association between *individual-based loneliness* and geographical characteristics (multilevel logistic regression)**

		Model A	Model B	Model C
		OR (95%CI), p-value	OR (95%CI), p-value	OR (95%CI), p-value
Index of Multiple Deprivation (IMD) (ref= 1 <sup>st</sup> quintile -least deprived)	2 <sup>nd</sup> quintile	1.44 (1.13-1.85), 0.004	1.26 (0.97-1.64), 0.087	1.17 (0.88-1.56), 0.281
	3 <sup>rd</sup> quintile	1.36 (1.05-1.78), 0.021	1.28 (0.97-1.70), 0.086	1.30 (0.97-1.76), 0.083
	4 <sup>th</sup> quintile	1.54 (1.17-2.04), 0.002	1.19 (0.88-1.60), 0.250	1.09 (0.78-1.50), 0.607
	5 <sup>th</sup> quintile-most deprived	2.0 (1.48-2.71), <0.001	1.38 (0.99-1.92), 0.056	1.13 (0.78-1.61), 0.520
	<i>p-value for trend</i>	<i>&lt;0.001</i>	<i>0.096</i>	<i>0.532</i>
Urban/rural character (ref= Urban)	Town and fringe	0.99 (0.76-1.28), 0.923	1.10 (0.83-1.45), 0.503	1.13 (0.84-1.51), 0.433
	Village	0.84 (0.63-1.12), 0.240	0.97 (0.71-1.32), 0.836	1.04 (0.74-1.44), 0.828
	Hamlet and isolated dwellings	0.91 (0.59-1.42), 0.688	1.18 (0.74-1.88), 0.472	1.44 (0.88-2.34), 0.147
	<i>p-value for trend</i>	<i>0.300</i>	<i>0.626</i>	<i>0.220</i>
Geographical regions (ref= London)	North East	1.17 (1.36-1.95), 0.534	1.10 (0.65-1.89), 0.716	1.37 (0.78-2.43), 0.275
	North West	1.45 (0.94-2.23), 0.085	1.32 (0.84-2.09), 0.222	1.37 (0.82-2.18), 0.245
	Yorkshire and The Humber	1.65 (1.08-2.53), 0.02	1.59 (1.01-2.52), 0.045	1.47 (0.90-2.40), 0.123
	East Midlands	1.59 (1.03-2.45), 0.035	1.51 (0.95-2.40), 0.083	1.54 (0.94-2.53), 0.089
	West Midlands	1.69 (1.10-2.59), 0.016	1.56 (0.98-2.45), 0.058	1.61 (0.98-2.64), 0.058
	East of England	1.27 (0.83-1.95), 0.264	1.37 (0.88-2.16), 0.167	1.48 (0.91-2.41), 0.110
	South East	1.2 (0.80-1.80), 0.386	1.21 (0.78-1.86), 0.394	1.34 (0.84-2.13), 0.211
	South West	1.66 (1.08-2.53), 0.019	1.87 (1.20-2.93), 0.006	2.06 (1.27-3.33), 0.003

Model A= geographical characteristics+age+gender

Model B= Model A+ social network

Model C= Model B + health characteristics

**Table 3. Association between *area-based loneliness* and geographical characteristics (multilevel logistic regression)**

		Model A	Model B	Model C
		OR (95%CI), p-value	OR (95%CI), p-value	OR (95%CI), p-value
Index of Multiple Deprivation (IMD) (ref= 1 <sup>st</sup> quintile-least deprived)	2 <sup>nd</sup> quintile	1.33 (1.07-1.66), 0.01	1.22 (0.97-1.53), 0.089	1.17 (0.93-1.48), 0.174
	3 <sup>rd</sup> quintile	1.34 (1.06-1.69), 0.014	1.23 (0.96-1.54), 0.097	1.22 (0.96-1.57), 0.109
	4 <sup>th</sup> quintile	1.68 (1.32-2.14), <0.001	1.35 (1.04-1.74), 0.022	1.31 (1.00-1.70), 0.046
	5 <sup>th</sup> quintile-most deprived	1.99 (1.51-2.60), <0.001	1.56 (1.17-2.09), 0.002	1.42 (1.05-1.91), 0.021
	<i>p-value for trend</i>	<i>&lt;0.001</i>	<i>0.002</i>	<i>0.011</i>
Urban/rural character (ref= Urban)	Town and fringe	0.77 (0.61-0.98), 0.035	0.86 (0.67-1.10), 0.230	0.87 (0.67-1.12), 0.277
	Village	0.91 (0.71-1.16), 0.436	1.09 (0.84-1.40), 0.521	1.16 (0.90-1.51), 0.252
	Hamlet and isolated dwellings	0.95 (0.64-1.39), 0.775	0.93 (0.61-1.40), 0.715	0.99 (0.65-1.52), 0.975
	<i>p-value for trend</i>	<i>0.235</i>	<i>0.916</i>	<i>0.649</i>
Geographical regions (ref= London)	North East	0.72 (0.48-1.10), 0.130	0.69 (0.44-1.07), 0.097	0.70 (0.45-1.11), 0.129
	North West	0.80 (0.56-1.13), 0.210	0.71 (0.49-1.04), 0.083	0.71 (0.48-1.05), 0.088
	Yorkshire and The Humber	1.02 (0.73-1.45), 0.883	1.02 (0.71-1.47), 0.914	0.99 (0.68-1.44), 0.962
	East Midlands	0.79 (0.55-1.13), 0.204	0.78 (0.53-1.14), 0.195	0.76 (0.51-1.13), 0.174
	West Midlands	0.87 (0.61-1.24), 0.441	0.77 (0.53-1.13), 0.182	0.77 (0.52-1.13), 0.190
	East of England	1.02 (0.73-1.42), 0.916	0.05 (0.74-1.49), 0.799	1.09 (0.76-1.56), 0.649
	South East	0.94 (0.68-1.29), 0.695	0.91 (0.65-1.27), 0.578	0.94 (0.67-1.33), 0.738
	South West	0.95 (0.67-1.34), 0.752	0.94 (0.65-1.36), 0.748	0.97 (0.66-1.40), 0.861

Model A= geographical characteristics+age+gender

Model B= Model A+ social network  
Model C= Model B + health characteristics

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