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Predicting the Prevalence of Loneliness in Old Age Across Small Geographical Areas in England

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Abstract

Objective: This study predicts the prevalence of loneliness among people aged 65 or over across small geographical units in England.

Method: It uses spatial two-level mixed-effects logistic regression model on data from a household survey and applies results to census data.

Results: There is a huge variation of prevalence of loneliness among older people across England, which cannot be explained by local area characteristics, and are not spatially correlated.

Discussion: This is the first attempt to estimate prevalence of loneliness among older people in England for small geographical units.

Some limitations: The survey contains one question on loneliness with three categories; more detailed measures could not be used. Missing data could not could not be imputed as it was not possible to rule out non-randomness. Finally, ethnicity and sexual orientation were not included in the models due to data limitations.

Public health implications: The method described in this paper can be used to design tailor-made interventions to address loneliness in later life in small geographical areas and to compare differences in prevalence across areas in a state, region or country.

Keywords: Loneliness; Local area; Later life

Introduction

Little academic effort has been invested in estimating prevalence of loneliness among older people across small areas in a country considering that most interventions to tackle it by public and charity sector organisations and community groups are localised.

There have been studies looking into particular regions or cities, but only one attempt at presenting the overall picture of loneliness across all local areas in a country. Such an exercise could help identify any hotpots and spatial patterns and inform joined-up interventions, services and programmes. Surveys are not large enough to obtain results for small geographical units with acceptable statistical power. Besides, census data do not record loneliness. This paper presents a novel approach that circumvents such limitations, replicable in principle in other countries.

Literature Review

Several definitions of loneliness have been proposed [1]. We follow an approach that views loneliness as a subjectively-defined gap. Two main socio-psychological approaches share this starting point: the interactionist and the cognitive perspective. Interactionism emphasises the importance of being without some definite needed relationships [2]. Cognitive approaches focus on the cognitive discrepancy between desired and actual relationships [3]. Interactionists distinguish between emotional and social loneliness-feelings stemming, respectively, from the perceived lack of emotional relationships and of social relationships. Cognitive authors highlight the importance of situational, environmental, personality, and cultural factors that mediate the cognitive processes

behind the subjective perception and evaluation of relationships. Both approaches underline the existence of a breach at the centre of the feeling of loneliness, which led to some authors to state that they share some characteristics in common [4].

Loneliness is a prevalent phenomenon in later life [5,6]. Factors have been associated with loneliness include being widowed, having low self-esteem, contacts with friends or family, social activity, well-being, and income comfort, living alone, low income, retirement, age, ethnicity, sexual orientation, poor health, mobility limitations, cognitive and sensory impairment (Victor and Yang, 2012; Dahlberg and McKee, 2014), material deprivation [7], poor hearing and olfactory dysfunction [8].

However, not all these associations have been consistently reported as significant. The literature is indicative that marital status and living arrangements or household size are strongly correlated with loneliness [5]. The evidence on gender is less conclusive: being a woman is more strongly associated, albeit perhaps mediated by widowhood [6]. Older lesbians, gay men, and bisexuals would be more at risk of feeling lonely [9].

Ethnicity was found significant in England [10] although cultural background could be more relevant than migration status per se [11]. Having a pet may lower the risk of loneliness, although a systematic review failed to find any convincing evidence [12]. Disability is a strong predictor of loneliness in later life [13,14] - though complex mediating processes [15]. The literature is also ambiguous about the importance of rurality. Higher levels of loneliness have been reported among older people living in rural areas [16] and urban areas [17], whereas Takagi and Saito [18] failed to detect any significant differences between urban and rural areas.

Loneliness in England seems to be spatially distributed [19]. Kearns et al. [20] suggested neighbourhood characteristics would be related to the prevalence of loneliness, including the frequency of social interactions with neighbours and the level of social support. Scharf and de Jong Gierveld [17] cautioned against interpreting associations between neighbourhoods and loneliness as unidimensional causal mechanisms given the complex interplay of neighbourhood-level factors such as crime, population composition, housing conditions, amenities, and local policies. We could only control for two local area characteristics: multiple deprivation and rurality given the spatial disaggregation-data on housing conditions or recorded criminal offences, for example, are only available at a higher level of geography.

Despite policy and services interventions to tackle loneliness in later life are very localised [21], academic efforts have either focused on regions within countries or particular towns. As far as we know, only one study surveyed loneliness across municipal and regional health authorities in the Netherlands [22], which found an unequal distribution across the country not withstanding, even a study across municipalities is too spatially aggregated to be useful for targeting interventions.

Data

We used the English Longitudinal Study of Ageing (ELSA) Wave 5 (2010/11), a representative (n=6,773) longitudinal survey of people aged 50 or over living in the community in England and the representative sample of 10 per cent of all individuals surveyed in the UK Census 2011. We excluded respondents in institutions in the ELSA dataset (82 records out of 10,274).

Based on the literature review, we included the following ELSA variables:

Loneliness. How often respondents feel lonely (1= "Hardly ever or never", 2=" Some of the time" and 3=" Often"). Holmén and Furukawa [23] recommend the use of a single question to measure loneliness among older people; however, single-item measures of loneliness – as opposed to multiple-item scales- may fail to fully capture some of its negative connotations and therefore may underestimate true levels of loneliness [24]. Consequently, the findings in this paper had better be considered as conservative. We compared this categorisation with a binary alternative: "Often" = "Lonely", the rest, "Not Lonely".

- Age band. 65-69 years, 70-74 years, 75-79 years and 80+ years.
- Gender. Female=0; Male =1.
- Highest educational attainment.

'No qualifications + National Vocational Qualification (NVQ) Level 1' (=0); "NVQ Level 2' (=1); 'NVQ Level 3 or over' (=3). NVQs are competence-based qualifications divided into five levels. Each NVQ level is equivalent to certain academic and vocational qualifications. An NVQ Level 3 corresponds to: two or more General Certificate of Education (GCE) Advanced ('A') levels; an Ordinary National Certificate or a National Diploma; a City and Guilds' International Vocational Qualification(IVQ) Technician or Advanced Diploma; a Scottish Higher; an Advanced Vocational Certificate of Education (AVCE); and a Business and Technology Education Council (BTEC)National qualification.

- Marital status. "Single/legally separated/divorced"; "married/civil partnership" and "widowed".
- Household size. "1 person" (=0); "2persons or more" (=1)
- Three or more people living in the same household represented only 1.8 per cent of the sample.
- Housing tenure.

"Renting / rent free" (=0), and "Own property outright or buying it with mortgage / shared ownership" (=1).

- (Self-reported) Health status. "Excellent", "very good", "good", "fair", and "poor".
- Pets ownership. Yes=1; No=0
- Activities of Daily Living (ADLs). ELSA records self-reported difficulty with:
- dressing, including putting on shoes and socks
- walking across a room
- bathing or showering
- eating, such as cutting up food
- getting in and out of bed
- using the toilet, including getting up or down

We aggregated the number of ADLs into "no difficulty", "difficulty with 1 ADL", "difficulty with more than 1".

- Eyesight condition (glaucoma, diabetic eye disease, macular degeneration, and cataract). Yes (=1) or no (=0)-less than 0.7 per cent of the sample reported more than one condition.
- Self-reported hearing. "Excellent", "very good", "good", "fair", and "poor".
- Social connectedness. We combined frequency and quality of contacts (in person, by telephone or email) with children, other relatives and friends [25]. Frequency was categorised as "Less than once a year or never" (=1), "Once or twice a year", "Every few months", "Once or twice a month", "Once or twice a week", and "Three or more times a week" (=6). Quality was defined as how much the respondent can open up if they need to talk with children, other relatives and friends, and was categorised into "not at all" (=0), "some", "a little", and "a lot" (=3). We multiplied frequency by quality so our indicator ranges between 0 and 18.
- Income. Equalized total benefit unit income
- Employment. In paid employment (=1) or not (=0)

Neither ethnicity (ELSA W5 only distinguishes between 'white' and 'non-white') nor olfactory dysfunction or sexual orientation (not included in ELSA W5) were included. To check for spatial variation across local areas we used the second-level confounders in multilevel models:

- Income Deprivation Affecting Older People score -i.e. the proportion of people aged 60 and over living in income deprived households.
- Local area rural/urban definition. Six categories: Urban (Sparse); Town and Fringe (Sparse); Village, Hamlet and Isolated Dwellings (Sparse); Urban (Less Sparse); Town and Fringe (Less Sparse); and Village, Hamlet and Isolated Dwellings (Less Sparse).

MSOAs are a geography created by the UK Office for National Statistics for the collection and publication of statistics across small areas of similar size. There are 6,791 MSOAs in England, with a population between 5,000 and 15,000 people and between 2,000 and 6,000 households. This is the lowest level of geographical disaggregation at which we can carry out statistical analysis on ELSA data. Moreover, MSOAs are small enough to provide insight for interventions and services. Only complete records were included in the analysis, as we do not have any additional information to reject the assumption that data are not missing at random. (Table 1) presents descriptive statistics.

Variable	(% in sample) (N=4,041)
Loneliness	
No	91.5%
Yes	8.5%
Age group	
65-69	31.5%
70-74	29.4%
75-79	20.9%
80+	18.2%
Gender	
Female	55.7%
Male	44.3%
Marital Status	
Married/re-married/civil partner	61.0%
Divorced/separated/single	14.5%
Widowed	24.6%
Housing Tenure	
Owner outright	77.8%
Mortgage	6.2%
Renting	16.0%
Self-reported Health	
Poor	8.1%
Fair	20.5%
Good	34.5%
Very good	27.5%
Excellent	9.4%
Hearing	
Poor or registered deaf	5.6%
Fair	18.8%
Good	34.7%
Very good	26.6%

Excellent	14.3%
Eye conditions	
None	58.8%
1	33.8%
2	6.7%
3+	0.7%
ADLs	
0	76.0%
1	12.2%
2+	11.7%
Educational Level	
No qualification + NVQ1	36.4%
NVQ2	17.9%
NVQ3	45.7%
Pets	
No	73.3%
Yes	26.7%
Household size	
1 person	33.7%
2+ persons	66.3%
Rurality	
Urban & Town	84.8%
Village & Hamlet	15.2%
Deprivation Index	
0.59->8.35 (Least deprived)	25.0%
8.35->13.72	26.8%
13.72->21.16	21.6%
21.16->34.21	16.3%
34.21->86.36 (Most deprived)	10.4%

Table 1: Descriptive measures.

The Census 2011 variables include:

- Marital status. Divorced/Separated (=0); Widowed (=1) and Married or civil partnership (=2)
- Age. 65-74 years old (=0); 75 years or over (=1).
- General health. 'Fair', 'Poor' ('Bad/Very bad') and 'Good' ('Good/Very Good').
- Household size.
- Gender

Method

We ran logistic regression models using loneliness as a dichotomous variable and compared them with ordinal logistic regression models on the original three categories of the loneliness measure. This paper only reports results from the logistic models because the findings for both specifications were similar.

The use of logistic models for prediction of binary outcomes is common in social sciences. They outperform alternative techniques such as neural networks, Markov random fields, support vector machines, or classification trees in terms of predictive power and misclassification error [26].

It is important to account for spatial autocorrelation in multilevel models, but if spatial correlation is not significant, simpler multi-level models can be applied [27]. We applied a spatial two-level mixed-effects logistic regression model on the ELSA data.

We excluded quantity and quality of social contacts from the final model as in specifications without mixed effects they were found not to be significant - perhaps because our social connectedness construct conflates significant and non-significant types of social relationship and modes of contact. For example, we could not distinguish between types of loneliness and the size of the support network or the frequency of social contacts are associated with social but not with emotional loneliness [6].

Unbiased multilevel models' regression estimates can be obtained with groups as small in size as 5 units provided there are at least 50 nested groups [28,29] which reduced the sample to 3,540 respondents (i.e. 38 per cent of all valid records) in 540MSOAs (out of 6,791 MSOAs in England). Chi-square tests weighted by MSOA could not reject the null hypothesis that the proportions in the subsample were equal to the proportions in the full sample. Therefore, we accept the sub-sample as representative. More over the Kolmogorov-Smirnov and Anderson-Darling two-sample tests found no significant differences in the distribution of loneliness by gender and age band between the sub-sample and the full sample.

Local-area regression results

(Table 2) Presents the results of the final model specification.

Variables	Estimate	Standard Error	z value	p-value
Marital Status				
Married/re-married/civil partner (base category)	1			
Single/Divorced/Separated	0.36	0.28	2.29	0.02
Widowed	1.03	0.26	3.96	0.00
Household Size	-0.99	0.24	-4.11	0.00
Housing Tenure				
Mortgage (base)	1			
Owner outright	-0.07	0.28	-3.27	0.03
Renting	-0.13	0.16	-2.80	0.09
Educational Attainment				
No qualifications (base)	1			
Educational level NVQ1	0.23	0.34	0.68	0.50
Educational level NVQ2	0.18	0.26	0.70	0.48
Educational level NVQ3+	-0.23	0.30	-0.75	0.46
Self-reported health				
Excellent (base)	1			
Very Good	0.59	0.38	1.56	0.12
Good	1.03	0.36	2.85	0
Fair	1.69	0.37	4.63	0
Poor	2.22	0.38	5.83	0
Pets	0.43	0.14	1.14	0.40
Income	-0.08	0.15	-0.55	0.58
Paid employment	-0.13	0.22	-0.57	0.57
Age				
Age 65-69 (base)	1			
Age 70-74	-0.17	0.17	-0.98	0.33
Age 75-79	-0.30	0.19	-1.56	0.12
Age 80+	0.09	0.19	0.47	0.64
Disability				
No difficulties with ADLs (base)	1			
Difficulty with 1 ADL	0.32	0.17	1.87	0.06
Difficulty with 2+ ADLs	0.38	0.18	2.11	0.03
Eye conditions				
No eye conditions (base)	1			
Eye conditions 1	0.12	0.14	0.9	0.37
Eye conditions 2	0.36	0.22	1.64	0.10
Eye conditions 3+	0.86	0.51	1.69	0.09

Hearing				
Excellent (base)	1			
Poor	0.33	0.29	1.16	0.25
Fair	-0.05	0.23	-0.2	0.84
Good	-0.1	0.21	-0.49	0.62
Very Good	0.2	0.21	0.97	0.33
Gender (Male=1)	-0.18	0.18	-1.05	0.29
Threshold	**Estimate**	**Standard Error**	**z value**	
0/1	-2.33	1.47	-1.59	
Random effects	**Var**	**St Dev**		
MSOA effect	0.14	0.37		
Rural/Urban	0	0		
Deprivation	0	0		

Table 2: Two-Level Mixed-Effects Logistic Regression Results Dependent variable: Probability of Feeling Lonely.

Being single, divorced or separated and widowhood are associated with a higher probability of loneliness compared to being married. Household size is inversely related. Owning a house outright and renting are negatively associated compared to paying a mortgage. Self-reported health exhibits a negative gradient. Having difficulty with one or more ADLs is positively associated. Owning a pet, education, income, paid employment age, hearing or eye sight problems, and gender are not statistically significant.

None of the second-level covariates are significantly associated with the probability of feeling lonely. Furthermore, no MSOA effects are significant. We ran a global Moran test to check for global spatial autocorrelation. This test consists of the ratio of the product of the prevalence of loneliness across MSOAs and its spatial lag with the cross-product of the prevalence of loneliness. The results, adjusted for spatial weights obtained via the nearest MSOA neighbour (k=1) for each MSOA, denote that the prevalence of loneliness is not spatially correlated (G-Moran's I under randomisation= 0.62; st dev= 41.96; p-value=0).

To predict the error, we used an internal resampling validation without backward step-down variable deletion on a logistic model with the same specification as above, including deprivation and rurality as regressors, but without MSOA mixed effects. We used a bootstrap (N=1,000) to correct for over-fitting. (Table 3) presents the results.

	Original sample	**Training sample**	**Test sample**	**Optimism**	**Corrected index**	**Boostrap (n)**
D_{xy}	0.5976	0.6046	0.5946	0.0099	0.5877	1,000
R^2	0.2036	0.2086	0.1993	0.0093	0.1942	1,000
Intercept	0.0000	0.0000	-0.0498	0.0498	-0.0498	1,000
Slope	1.0000	1.0000	0.9736	0.0264	0.9736	1,000
E_{max}	0.0000	0.0000	0.0154	0.0154	0.0154	1,000
D	0.0935	0.0960	0.0915	0.0045	0.0890	1,000
U	-0.0005	-0.0005	0.0001	-0.0005	0.0001	1,000
Q	0.0940	0.0965	0.0914	0.0051	0.0889	1,000
B	0.0693	0.0689	0.0696	-0.0006	0.0699	1,000

D_{xy}= Somers' rank correlation
R^2= Generalised Nagelkerke R^2 index
Intercept=calibrated intercept
Slope= calibrated slope (equal to shrinkage factor accounting for overfitting)
E_{max}= maximum absolute difference in predicted and calibrated probabilities
D=discrimination index
U=unreliability index
Q=overall quality index (logarithmic probability score)
B=Brier or quadratic probability score

Table 3: Internal Validation of Fitted Model.

The bias-corrected apparent Somers index (D_{xy}), the shrinkage factor and the maximum absolute error in predicted probability (E_{max}) are all within acceptable values. The model shows good calibration, with corrected intercept close to 0 and slope close to 1. With the Somers D_{xy} index we estimated the corrected c-statistic of concordance after adjusting for over-optimism, which suggests (c=0.794) the model is sensible. The unreliability index 'U' indicates the model is almost negligibly miscalibrated. The corrected Q and D are very close to each other - an indication that the logistic model holds true. Finally, the corrected Brier quadratic probability score B is below the 0.25 cut - off value and hence acceptable.

We also checked for co-linearity between the variables but the pairwise correlation coefficients were not problematic-not even those between hearing and eye conditions and health status. Having found no significant global spatial neighbouring effects, we applied the regression results to Census 2011 data; otherwise, country-wide results would have been biased as spatial autocorrelation adjustment would not have been feasible. The rationale was twofold: this procedure would render the complete picture of loneliness by MSOA and the lack of global autocorrelation does not preclude the existence of localised clusters of loneliness only detectable if all the MSOAs are included.

Nation-wide results: Using aggregated Census 2011 data to predict prevalence of loneliness

The Office for National Statistics (ONS) carried out a population census in England (and Wales) on 27 March 2011, which did not include questions about feeling of loneliness or ADLs but included other covariates in the regression model above.

We ran a reduced version of the model with the significant variables in Table 1other than ADLs (Table 3) and with no second level covariates as none were found to be significant. This modified model was run on the extended sample of the ELSA respondents with full records (n= 9,316), given that the MSOA identifiers were omitted in this specification and hence the requirement to have at least 5 records per MSOA did not apply. (Table 4) presents the results.

Variables	Estimate	Standard Error	Z value	Probability
Intercept	-4.55	0.37	-12.32	0.00
Divorced/ Separated	0.54	0.28	1.91	0.06
Poor Health	2.32	0.37	6.21	0.00
Fair Health	1.77	0.36	4.93	0.00
Age 75-79	-0.31	0.19	-1.67	0.09
1-person household	-0.97	0.24	-3.98	0.00

Table 4: Logistic Regression Results Reduced model on Extended Sample Dependent variable: Probability of Feeling Lonely

The ONS applied these coefficients to the 2011 Census Microdata file. (Figure 1) and (Map 1) show that the distribution of the prevalence of loneliness across the MSOAs exhibits a high variation across small areas ranging between 5.24 and 19.26 per cent (Figure 1).

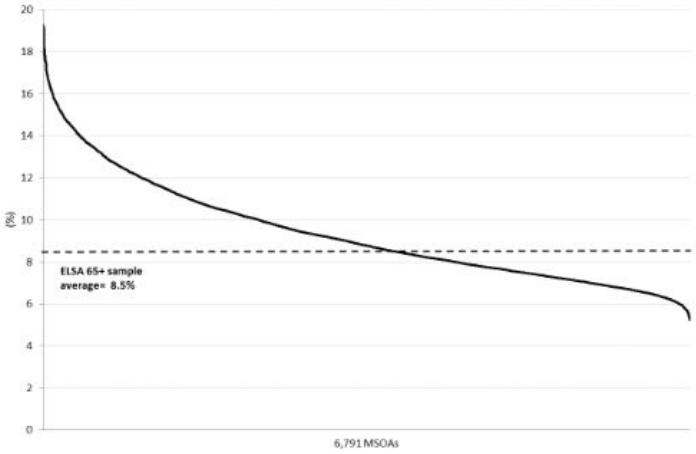
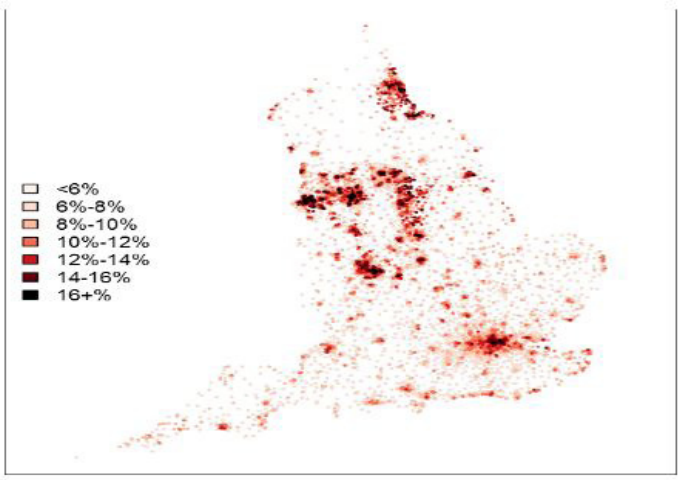


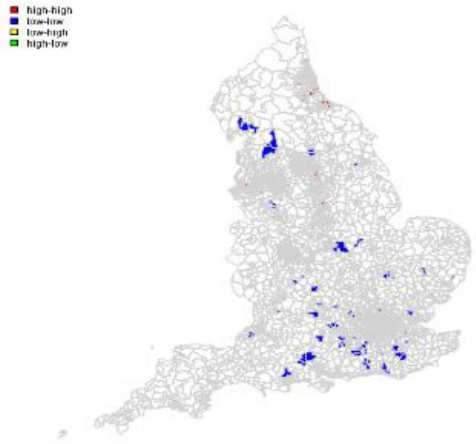
Figure 1: Predicted Risk of Loneliness by MSOA among population aged 65 or over, England Map.



Map 1: Predicted prevalence of loneliness among residents aged 65 or over in England.

We computed the local Moran's I statistics with saddle point approximation to detect any significant local 'hotspots' (MSOAs with prevalence levels significantly above the mean surrounded by neighbouring MSOAs with similarly high values) and 'cold spots' (spatial clustering of MSOAs with values below the mean is surrounded by neighbouring areas with prevalence levels also significantly below the mean) of loneliness in later life.

We found a few significant spatial clusters-722 local area hotspots and 127 cold spots (out of a total 6,791 MSOAs) plus9 spatial outliers (see (Map 2) and Supplemental Table 1).



Map 2: Hot and cold spots of loneliness. Local Moran I with saddle point approximation.

Discussion

ELSA is a representative survey of older people in England but covers a sub-sample of small areas. The Census 2011 covers the whole country but has not recorded loneliness. How can we predict prevalence of loneliness by local area? This paper presents one approach: predict prevalence of loneliness among people aged 65 or over for as small the geographical unit as feasible, given existing survey data. Re-fit the original model with the covariates included in the Census and check for its validity compared to the extended specification. Provided no spatial effects are detected, apply the results on Census individual records.

The main finding is that there is a huge variation of prevalence of loneliness across small areas in England which is not spatially correlated and cannot be explained by local area characteristics. This is in line with Moorer and Suurmeijer [19], who reported significant spatial variations in loneliness in later life in England unrelated to neighbourhood characteristics.

With regards to predictor variables, the results tend to confirm what has been identified in the literature: widowhood, housing tenure, and poor self - reported health are associated with higher prevalence of loneliness while household size is inversely associated. The literature is not unanimous about the effects of age, gender, eyesight and hearing conditions or owning a pet on loneliness; we found these covariates not statistically significant. We failed to find a significant association between gender and the probability of feeling lonely. We also failed to find any significant association between loneliness and rurality or multiple deprivation of the area.

A few significant local clusters were identified which may help the design of interventions in these areas. Unpacking the determinants of such pockets of local spatial correlation demands further localised research. A number of limitations should be mentioned.

Parkes and Kearns [30] recommended that survey data should be ‘‘complemented by detailed neighbourhood case studies in order to elucidate potential mechanisms for neighbourhood effects on health for particular groups in specific residential contexts’’. Scharf and de Jong Gierveld [17] pointed out that this recommendation is applicable to spatial effects on loneliness in later life. Further analysis is required in this regard, because some local area aspects not included in this paper such as terrain characteristics and amenities in an area have been reported to be statistically associated with loneliness [31].

Although our dichotomous indicator of loneliness has been validated [13], it does not distinguish between emotional, social or psychological underlying factors. We could not check whether missing data biased the results, as we could not rule out whether missingness was a random feature of the data or not.

Following Toepoel [25] we combined indicators of frequency and quality of social contacts. Further research is needed to ascertain the theoretical and empirical validity of this combination, considering the quality of social engagement is more protective against loneliness than the quantity of contacts. We could not control for ethnicity or sexual orientation.

Conclusion

This paper presents a novel approach at predicting the prevalence of loneliness among older people across small areas in a country.

The method described in this paper can be used to design tailor-made interventions to address particular characteristics in each area. Even if the initiatives are localised and administered by local governments or locally-based organisations, having a nation-wide picture of prevalence of loneliness across local areas is a useful tool towards designing and evaluating interventions and services.

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