When the old become lonely: Contextual determinants of late life loneliness in Europe

Linda Ejlskov*, Jesper N. Wulff

1The Public Health and Epidemiology Group, Department of Health Science and Technology, Aalborg University

2Department of Economics and Business Economics, Aarhus University

*Corresponding author.

Aalborg University
Niels Jernes Vej 14, 3-207
DK-9220 Aalborg East
Email: lej@hst.aau.dk
Abstract
Loneliness is a serious impediment to healthy ageing. Recent developments in the literature suggest that where you live matters for the risk of being lonely. Several contextual influences on the susceptibility of feeling lonely have been suggested but only a few have undergone empirical scrutiny. The aim of this study is to expand upon the current body of literature on cross-country variations in late life loneliness. Several country and regional level determinants of late life loneliness in Europe are investigated. A three-level cumulative mixed model analysis is performed on 10,166 individuals aged 65 or older from 23 European countries using data from the 6th wave of the European Social Survey. The analysis indicates that both the region in which the individuals live as well as the country are important when explaining geographical variations in late life loneliness. Levels of freedom, equality and regional wealth are very strongly negatively related to late life loneliness while an individualistic culture is very weakly related. Thus, the previous focus on culture as the sole determinant of variations in loneliness across countries is questioned. This study opens up for the idea that improving contextual country- and regional level determinants might be worthwhile when the aim is to alleviate late life loneliness and thus improving both the quality of life and health of the elderly.

Keywords: Europe; healthy ageing; loneliness; cross-country; multilevel modelling; contextual determinants; wellbeing
Introduction

Where you live matters for how lonely you are. While previous research has focused on proximal individual level determinants, the context in which an individual lives is emerging as pivotal to understanding late life loneliness (Yang & Victor 2011; de Jong Gierveld & Tesch-Römer 2012). Late life loneliness is an important theme for both researchers and policymakers (De Jong Gierveld 1987; Victor et al. 2000). It makes it more difficult to live a happy life (Cacioppo et al. 2010) and is connected to serious adverse health outcomes such as dementia (Holwerda et al. 2014), cognitive decline (Wilson et al. 2007), cognitive functioning (Ellwardt et al. 2013), depression (van Beljouw et al. 2014), high systolic blood pressure (Hawkley et al. 2006), cardiovascular disease (Christiansen et al. 2016) and mortality (Shiovitz-Ezra & Ayalon 2010; Patterson & Veenstra 2010; Luo et al. 2012). The empirical evidence has lead Cacioppo and Patrick (2008, p.5) to suggest that loneliness is “… compounded in ways that may be hastening millions of people to an early grave”. Considering the challenge of an increasingly ageing population in Western countries, more knowledge about the factors connected to late life loneliness is vital. Such knowledge may help inform policy initiatives aimed at alleviating loneliness among the elderly.

A common used explanation of cross-country variation in loneliness is cultural differences (e.g. Rokach & Neto 2005; Rokach et al. 2002; Lykes & Kemmelmeier 2014). Yang & Victor (2011) and Dykstra (2009) propose political and economic factors as contextual alternatives or complements to cultural differences at the country level. As the cultural dimensions have often been the sole country-level predictor in previous studies (as in i.e. Lykes & Kemmelmeier 2014), it is hard to assess whether the observed association with loneliness simply indicates other underlying country differences in terms of e.g. economic stability and welfare expenditure. As a result, we still know very little about contextual effects on loneliness (Dykstra 2009). This has lead researchers to call for more cross-country comparative research in order to disentangle the mechanisms underlying loneliness (Fokkema et al. 2012; Hawkley 2015).
In this study, we investigate the importance of both country and regional level determinants for loneliness in old age. We show that a three-level mixed cumulative model including individuals within regions within countries provides a better predictive model of the variation in loneliness compared to only considering individuals within countries. This is assessed through an information theory approach using the second order Akaike Information Criterion. Further, we model six country- and three regional level determinants and investigate their association with loneliness. We find that two quality-of-democracy indicators and regional wealth are substantial strong predictors of late life loneliness while an individualistic culture only plays a minor role.

Geographical variations in late life loneliness levels
The existing literature has focused solely on country- or individual level differences (Stickley et al. 2013; e.g. Dykstra 2009). Whether geographical areas within countries also have an importance for late life loneliness remains an open question. Obtaining such knowledge would be a big step in discerning contextual factors from each other in their importance for cross-country variations in late life loneliness. In turn, we expect such knowledge to foster an understanding of the contextual determinants of late life loneliness that may serve as effective intervention targets to prevent or reduce loneliness and improve quality of life (Hawkley 2015). Some evidence already indicates substantial geographic variations in loneliness even across regions within countries (Yang & Victor 2011; Fokkema et al. 2012). For example, loneliness is often more prevalent in more densely populated areas and areas with more economic deprivation (Victor & Scharf 2005). This leads to the first research question (RQ):

RQ: Do regional and country level differences more accurately predict differences in late life loneliness compared to country level differences alone?
Understanding determinants of loneliness

As people grow old, they are more likely to encounter loss of relationships due to age-related causes and less likely to initiate new relationships or be part of new networks (Singh & Misra 2009). But while it is natural to equate loneliness with lack of social contact in terms of quality or quantity – often referred to as objective social isolation – this is not the case. Loneliness is a subjective feeling and is often called perceived social isolation for this reason (Gierveld 1998; Cacioppo & Patrick 2008; Hawkley & Cacioppo 2010; De Jong Gierveld 1987; Hawkley 2015). Thus, some people can lead a life being socially isolated without feeling lonely, while others can have a rich social life in both quality and quality but still feel lonely (Hawkley & Cacioppo 2010). The reason for this discrepancy between actual and perceived social isolation, it seems, lies in differences in the subjective evaluation of objective social isolation which in turn is influences by a range of other factors (De Jong Gierveld 1987). That is, loneliness has to be triggered by internal stimuli in order to appear. We propose that these internal stimuli are influenced by contextual factors.

Several possible explanations of country level differences in levels of loneliness have been suggested. Lykes and Kemmelmeier (2014) find that individualistic societies experience lower levels of loneliness compared to collectivistic societies. However, the authors do not consider alternative contextual explanations for the found association between culture and loneliness. Proponents of the cultural explanation of variations in loneliness argue that different cultures give rise to different expectations of loneliness. These expectations of social relations are reflected in different levels of loneliness and the strength to which different measures of social relations determine the extent of loneliness (Lykes & Kemmelmeier 2014; Rokach et al. 2002). However, expectations alone cannot explain the perceived gap between expected and observed social relations. Second, it is very difficult to isolate the mechanisms in which culture works to influence evaluations of objective social isolation (Yang & Victor 2011). Fokkema, de Jong Gierveld & Dykstra (2012) focus on differences in country demographic characteristics and find that loneliness in Southern and Central Europe is mostly attributed to not being married, economic
deprivation and poor health. However, they do not focus on contextual country differences and state this area to be an open question. Yang & Victor (2011) investigate the association between age and loneliness in 25 European nations based on the third round of the European Social Survey. The authors find that different effects of age on loneliness across countries and identified several country-level variables could possibly account for the different levels of loneliness across countries. In addition, they propose levels of migrations within a country, economic and political transformations as well as systems in the different countries to be important predictors but do not test them.

Using the biological approach to loneliness suggested by Cacioppo & Hawkley (2010), living in an economical and deprived area may increase the likelihood of triggering internal. In turn, this might make individuals more likely to feel lonely because of an unconscious higher reliance on the group in order to survive compared to places with more security, stability and wealth. This leads to the second research question:

**RQ:** To what extent do contextual factors predict late life loneliness in Europe?

**Methods**

**Study population**

The study population was obtained from the sixth round of the European Social Survey (ESS) conducted in 2012 (ESS Round 6: European Social Survey Round 6 Data 2012). The ESS aims to monitor and chart both structural systems and social structures as well as individual attitudes, beliefs and behaviour patterns. It is a cross-national repeated cross-sectional survey started in 2002 and repeated every second year. The 6th round of ESS focus on personal and social wellbeing and democracy in addition to the core modules. 29 European countries participated with the target population being all persons aged 15 and over resident within private households (ESS Round 6: European Social Survey 2012). A design weight has been included in the analysis to correct for the sampling design where all individuals have not had equal
probabilities for selection. In total 54,673 participants from the 29 surveyed countries answered the interview-administered questionnaire.

To analyse the importance of geographical units lower than the country-level, we use the NUTS classification to classify the first registered geographical level below the country level. The first geographical unit just below the country level were classified depending on the size of the country (Eurostat 2014).

Albania, the Russian Federation, Israel, Ukraine and Kosovo were not covered by the NUTS classification in this round and to ensure comparability these countries were removed from the analysis. Furthermore, Cyprus, while being covered by the NUTS nomenclature, had no data below the country level and were also removed. A total of 43,891 respondents from 23 countries encompassing 128 regions remained hereafter. Only participants aged 65 or older were included in the study resulting in a final sample of 10,166 participants ranging from 65 to 101 years of age. Detailed descriptive information and sample sizes from the 23 remaining countries can be found in the supplementary materials (D).

**Measures**

*Loneliness*

Loneliness is measured by a single item from the CES-D depression scale. The participant is inquired about how much of the time during the past week the respondent felt lonely. The ordinal response options are 0=”none or almost none of the time”, 1=”some of the time”, 2=”most of the time”, 3=”all or almost all of the time”. Relying on a single item measure of loneliness has received criticism. It is questioned whether a single item is sufficient to capture a concept as complicated as loneliness. Furthermore, due to the social stigma attached to feeling lonely, loneliness measures inquiring directly about loneliness tend to elicit lower intensity and prevalence. Thus, when possible more comprehensive indirect measures such as the UCLA- or the de Jong Gierveld scale are preferred (Hawkley 2015). Still, previous studies have shown that this single item loneliness measure is highly correlated with more
comprehensive measures (Lykes & Kemmelmeier 2014; Yang & Victor 2011). Additionally, a study showed that the same loneliness measure from the ESS round 3 was cross-country invariant thus indicating that this measure is comparable across countries (Lykes & Kemmelmeier 2014). In conclusion, while a more comprehensive measure of loneliness is preferable, the single item measure of loneliness used in this study should be sufficient to investigate cross-country variations in loneliness.

Confounding variables

The following determinants at the individual level identified as having potential confounding effects by Hawkley (2015) and Lykes & Kemmelmeier (2014) were included. To heighten comparability between the studies, the determinants have been operationalized in a similar way to Lykes & Kemmelmeier (2014) and Fokkema et al. (2012). Age was included as a continuous variable ranging from 65 to 101. Gender was coded as female=1 and male=0. Self-rated health was measured by the degree to which the individual felt healthy. Educational level was categorized as low, intermediate and high. Income satisfaction was dichotomized as feeling life was difficult on the present income=1 or not=0. Household size was dichotomized as living alone=1 or living with others=0. Marital status was categorized as having a partner=0, separated or divorced=1, widowed=2, never married or in a legally registered relationship=3. Frequency of contact was measured through how often the respondent meets socially with friends, relatives or colleagues going from every day to never. Number of confidantes the individual could talk to ranging from 0 to 10 or more. Lastly, social participation was measured through whether the respondent was involved in voluntary work within the last year=0 or not=1 and two reciprocity measures through the degree of whether the respondent believed it either receive or provide help to people the respondent are close to (van Raalte et al. 2012). Due to the focus of the present study we will not go into detail with the distribution of the confounding variables in this paper. For further information on the confounding variables please see the supplementary materials (Appendix D) that shows weighted country-level means for the individual level determinants.
Country level measures

Six country-level measures were included in the analysis based on Yang & Victor (2011) and Dykstra (2009): Culture, three measures of the quality of the democracy in the respective countries, income inequality and per capita expenditure on health.

Culture: The 23 countries are assigned a score on individualism vs. collectivism using Hofstede’s index scores found on the author’s website (Geert Hofstede 2015) in a similar manner to Lykes & Kemmemeier’s (2014) study.

The quality of democracy (QoD) is measured by The Democracy Barometer (DB), which is an instrument designed to measure the quality of established democracies using three principles Freedom, control and equality (Merkel et al. 2014). The three components have been created following the guidelines from Merkel et al. (Merkel et al. 2014) with equal weighting. The freedom principle refers to the absence of heteronomy, the existence and guarantee of individual liberties as e.g. the inviolability of the private sphere. In a country high on the freedom measure no transgressions are committed by the state in terms of torture or other cruel, inhumane or degrading treatment or punishments. Furthermore, a high homicide rate and violent political actions restrict the effectiveness of the right to physical integrity and thus, affect freedom in a country negatively. Freedom is an indication of the right to free conduct of life such as freedom of religion, freedom of movement, freedom of opinion and association and equality before the law. The control principle measure more administrative aspects and refers to the degree of free, regular and competitive elections, the control of the executive and legislature powers, and governmental capabilities in terms of availability of resources and conditions for efficient implementation of policies. The equality principle measures transparency in political processes and incomes, freedom of information, absence of corruption, equal participation rights and whether all citizens’ preferences are adequately represented in the political decision-making process. All three measures can range from 0-100 with 100
being the most positive indication of a high degree of the three measures principles (Bühlmann et al. 2012; Merkel et al. 2014).

Income inequality is measured using the Gini Coefficient. A Gini coefficient of 0 indicates perfect equality in terms of distribution of the disposable income across society and 100 indicates perfect inequality (Harper & Lynch 2006). Expenditure on health is measured through per capita total expenditure on health in international dollars for each country (World Health Organization 2014).

Regional level measures
Three regional level measures have been selected: Net immigration, population density and GDP per Inhabitant. Net immigration gives the exact number of immigration in 2011 except for United Kingdom and Belgium where 2010 is used due to missing information in 2011. A negative number indicates emigration and a positive indicates a net surplus of immigration. Population density measures how densely populated a region is in 2011. Population density is calculated by the total population in the region divided by the surface area. For United Kingdom 2010-data are used due to missing data in 2011. GDP per inhabitant is measured in Euro and indicates the level of wealth in a region (Eurostat 2014). Due to skewed distributions all three regional measures are log transformed.

Statistical analysis
The evidence indicates that including regions as well as countries adds to the explanatory power of the model when explaining across-country variations in loneliness (see the results section). Thus, the statistical analyses were performed using a three-level cumulative logit mixed model with individuals nested within regions nested within countries. The statistical analyses were performed using the statistical software environment R (R. R Core Team 2015). The different libraries used in addition to the base package can be found in the supplementary materials section A. The most pivotal packages are mentioned in the paper. The cumulative link mixed model were estimated using the R-function clmm (Christensen 2015) using the Laplace approximation with standard unstructured thresholds.
The clmm package models the cumulative probability of the $i^{th}$ individual falling in a category higher than the $j^{th}$ loneliness category ($J=4$) with the country and region effects to be random assuming that both random effects are IID normal: $u_{\text{country},i} \sim N(0, \sigma_u^2)$ and $v_{\text{region},i} \sim N(0, \sigma_v^2)$ and that the odds are proportional across response categories. In order to be able to compare effect sizes all country- and regional-level variables have been standardized. The beta coefficients may be interpreted as the rise or fall in the log odds of experiencing a higher degree of loneliness when the variable of interest increases by one standard deviation. The variance inflation factors being below ten for all of the predictors gave no cause for concern (O’Brien 2007). In order to correct for sample selection bias resulting from the sampling design, a design weight was included in both the statistical analyses and the calculation of means and variances of the individual level measures in line with the recommendation from the ESS (Europan Social Survey Round 6 2014). A few variables had small amounts of missing data on the individual level. Information on missingness for each of the included variables can be found in the supplementary materials (Appendix B). Furthermore, the regional values for GDP pr. inhabitant were missing for the Swiss and Icelandic regions and for one of the subcomponents to the QoD freedom principle for Slovakia on a country level. All missing information were imputed using random forest imputation via the R-package missForest (Stekhoven 2011). The plausibility of the imputed regional values for GDP pr. inhabitant for the Swiss and Icelandic regions and the imputed country value for the QoD freedom principle for Slovakia were assessed by checking whether the imputed values were realistic when compared to comparable countries and regions (see Appendix E).

**Akaike’s Information Criterion**

Evidence for the hypotheses were evaluated using the information theoretic approach through the second-order Akaike’s Information Criterion ($AIC_c$) (Burnham & Anderson 2002; Akaike 1981). $AIC_c$ balances model fit and model complexity. It allows us to be concrete about the probability that a given model is the best in the model subset, which makes it possible move beyond the arbitrary dichotomies of null hypothesis testing. A final advantage of $AIC_c$ in the context of our study is that it opens up for
incorporating the uncertainty of model selection into our estimates: Instead of basing our inferences on one selected model, we can base our point inference on the entire set of models. These model-averaged estimates are often more honest in terms of precision and bias than solely the estimates from the selected best model (Burnham & Anderson 2002; Burnham & Anderson 2004; Gill 1999).

Results

Variation in loneliness levels within and between countries

Mapping mean levels of loneliness both across countries and regions shows that some countries have large variations in late life loneliness while some have none (Figure 1).

< Insert Figure 1 about here >

Figure 1 shows a north-south divide in loneliness, thus confirming the observed pattern from previous studies (Dykstra 2009). It further illustrates how some countries have large variations in loneliness levels across regions while others have very small variations. Lithuania, for example, while generally scoring higher than average on loneliness compared with the rest of the investigated countries spans almost one point in the mean level across the different regions. In comparison, the four regions of Norway score very similar and are all below the mean loneliness average of the countries.

Figure 2 shows the random effects incl. 95 percent confidence intervals for the 23 countries and the 128 regions, respectively. We observe greater variation in loneliness levels between countries than between regions. At the regional level, we observe a large variation between the random effects at the negative and positive extremes. This confirms the intuition gained from Figure 3, as some regions have very different levels of loneliness. Based on these observations, we expect that adjusting for country and regional level random effects will result in a superior prediction of loneliness levels.

< Insert Figure 2 about here >
We formally assess whether we should adjust for both country and regional level effects by relying on an information-theoretic procedure through the AICc measure described previously. Table 1 compares the AICc modelfit measures for a two-level mixed cumulative logit with individuals nested within countries to a three-level model with individuals nested within regions nested within countries. Delta AICc is calculated as the AICc value for the more complicated model with individuals nested within both regions and countries minus the AICc for the simpler model with individuals nested within countries. The AICc weight is the ratio of delta AICc for model relative to the other model (Burnham & Anderson 2002).

\[ \text{Delta AICc} = \text{AICc value for the more complicated model} - \text{AICc value for the simpler model} \]

A ΔAICc of 5.38 indicates considerably less support for the simpler model including only random intercepts for countries. The AICc weight for the more complicated model indicates that given the data, this model has a 93.6 percent chance of being the best one amongst these two models whereas the simpler model only has a 6.4 percent chance of being the best model. The calculated evidence ratio of 14.63 \((0.936/0.064)\) indicates that the more complicated model including both countries and regions are 14.6 times more likely to be the best model given the data. This analysis provides strong evidence that including both regions and countries when explaining the variations in loneliness is appropriate. Consequently, the following analysis focuses on both country- and regional-level determinants of cross-country variations in loneliness.

*Descriptive statistics*

*Country level characteristics*

Figure 3 shows descriptive characteristics of the six possible country-level contextual determinants of loneliness. The Gini Coefficient ranges from 22.9 in Norway to 35 in Bulgaria. The Netherlands has the highest health expenditure in percent of GDP (11.96%) followed by France (11.63%) and Denmark (11.15%). Estonia has the lowest percentage expenditure (5.96%). As reported in previous research, Western countries tend to be more individualistic and Eastern and Southern more collectivistic. In terms
of the democratic quality there also seems to be distinct variation across Europe. While the three measures tend to follow each other this is not always the case. For example, Iceland has scored very high on both freedom and equality, but rather low on control. France scores almost the same as Bulgaria in terms of freedom and control and Lithuania scores quite high on control but scores low on both freedom and equality. The Northern European countries all tend to score high on all three principles. Appendix E in the supplementary materials provides exact scores and sample sizes for the 23 countries.

Regional level characteristics
The three Europe maps in Figure 4 show the distribution of the net immigration, the GDP pr. inhabitant and the density in each of the 128 NUTS-regions. All three regional determinants show a high variation in some countries and a low in others. The net immigration across regions varies from a net negative immigration of 47,999 in the region Île de France in France to a positive net immigration of 76,482 in the region Bayern in Germany. There seems to be a tendency to a positive net immigration in Central Europe and a negative in Eastern Europe, parts of France, Portugal and Span and Ireland. Unsurprisingly, the regions with the highest GDP pr. inhabitant were the Scandinavian countries with the Norwegian region of Oslo and Akershus ranking highest with 72,600 Euro pr. inhabitant. However, Île de France ranked 7th highest with a GDP on 52,300 Euro pr. inhabitant and London 9th despite both regions residing in countries with tendency to a lower GDP pr. inhabitant. The Eastern European nations stand out in terms of a very low GDP pr. inhabitant very consistently across the different regions. The two regions with the lowest GDP pr. inhabitant both reside in Bulgaria with 3,400 and 4,700 Euro pr. inhabitant for the regions Yogo zapadna I Yuzhna Tsentralna and Severena I Iztochna respectively. In terms of density, there is a very clear pattern of most regions in Europe having a low density with a few regions that stand out. The densest regions are all regions including main capitols with Région de Bruxelles-Capitale in Belgium being the most densely populated (7131.1) followed by London in the UK (4984.4), Berlin in Germany (3921.7) and Prague in the Czech Republic (2550.2). The least densely populated region is Landsbyggö in Iceland (1.2).
Multivariate analysis

Table 2 shows the variance components and the model fit for the empty and the base model. The empty model includes only the random intercept for country and region. The base model further includes all of the individual-level determinants that are expected to confound the association between country- and regional-level determinants and loneliness. The variance partition coefficient (VPC) indicates that 12.8 percent of the variation in loneliness is attributable to country- and regional-level determinants.

Table 3 shows the log odds, standard errors (SE) and exact p-values for the standardized country- and regional level determinants. Also included for each model are the two variances for country and regions, respectively, the model AICc, the difference in AICc from the best model (QoD - Equality) and finally the AICc weight. First, each contextual determinant has been included separately in the base model (1) with all of the individual level confounding variables. Second, all of the contextual and individual determinants have been included together in a full model. The table showing the estimates for all determinants including the individual level confounders can be found in the supplementary materials (C).

The best model judged by AICc is the one including the QoD measure equality followed very closely by the one including the QoD principle freedom. Both models have a 46 percent probability of being the best model in the candidate set of models and therefore clearly outcompeting the other models in the set.

Incrementing either of the two QoD variables by one is associated with a decrease in the probability of belonging to a higher loneliness category, holding other model variables equal. Both variables also exhibit substantial effect sizes in terms of log odds in the full model. The full model is the third best performing
model and has a 4 percent probability of being the best model in the model set. The fourth best model contains the regional-level GDP pr. inhabitant. This model has a 2 percent probability of being the best model. Incrementing regional-level GDP pr. inhabitant by one standard deviation is associated with a decrease in the log odds of 0.21 of belonging to a higher loneliness category holding other model variables constant. This coefficient is somewhat smaller in the full model. Finally, on a fifth place we find the model including health expenditure, which is estimated a two percent probability of being the best model. A higher health expenditure is associated with a substantial decrease in the log odds of belonging to a higher loneliness level. In the full model, health expenditure’s coefficient is attenuated almost to zero.

The model including our culture variable is one of the poorest performing models. The model has a probability of practically zero of being the best model in our candidate set. The relationship between culture and loneliness is consistent with previous research with the coefficient exhibiting a modest decrease in the log odds of belonging to a higher category of loneliness. When accounting for the other contextual variables in the full model, the coefficient on culture is shrunk to zero. This strongly indicates that loneliness is more accurately predicted by the other contextual variables.

< Insert Table 3 about here >

Instead of just selecting the estimates from the best model, we perform the final step of our information-theoretic approach and compute unconditional model-averaged estimates. We present these graphically in Figure 7 sorted by the strongest predictors of late life loneliness.

< Insert Figure 5 about here >

Not surprisingly, QoD freedom and equality are the top predictors of loneliness both associated with a substantial negative change in the log odds of belonging to a higher loneliness category. The model-averaged coefficient on the regional-level predictor GDP pr. inhabitant was also substantial showing a negative relationship to loneliness. The model-averaged estimate of the coefficient on health expenditure
was surrounded by considerable uncertainty. Finally, it is clear that an individualistic culture is very weakly related to loneliness when basing point inference on our entire set of models. This strongly suggests that the individualistic culture variable is a very weak determinant of late life loneliness compared to the contextual variables QoD freedom, QoD equality and GDP pr. inhabitant.

**Discussion**

The aim of this study was to expand upon the current body of literature on cross-country variations in late life loneliness. In line with our expectations, a much more accurate prediction of late life loneliness was achieved by accounting for both country- and regional level differences. This confirms the suggestions made by Yang & Victor (2011), Fokkema et al. (2012) and Victor & Scharf (2005). Victor & Scharf (2005) suggest that specific neighbourhood characteristics may engender loneliness among the elderly. While the present study captured regional and not neighbourhood characteristics, its results still point towards the importance of lower level contextual determinants of loneliness.

Consistent with our expectations an individualistic culture was associated with lower late life loneliness when included as the sole contextual predictor. This was consistent with previous studies (Lykes & Kemmelmeier 2014; Rokach et al. 2002) where the relationship between culture and loneliness had been investigated without accounting for important contextual factors. Also in line with our expectations was that the influence of culture was minimal compared to other contextual predictors. Instead, our analysis suggests that the quality of the democracy in terms of the degree of freedom and equality, and GDP pr. Inhabitant are strong contextual determinants of loneliness. According to Freitag and Bühlm (2009), a high quality of democracy - in terms of democracies where authorities are seen as incorruptible, where political interests are proportionally represented and where the state institutions reduce income disparities - fosters social capital and individual trust. Furthermore, a high quality democracy is also associated with better human development and social equality (Bühlmann et al. 2012). Thus, the reason for the associations between freedom and equality and late life loneliness may be that individuals living in
countries with more freedom and quality feel safer in their everyday life and social relations. As proposed earlier, this could mean that the underlying mechanisms triggering loneliness are less likely to become active due to a smaller dependence on social relations for their safety and survival.

In this study, a region’s economic activity is an important predictor both in terms of the average standardized association with loneliness and in terms of the model fit even when considering the individual’s income, education, gender, age and social relations. This is consistent with the suggestion by Dykstra (2009) that the level of wealth in the areas in which we live matters for loneliness levels. The findings indicate that the level of immigration/emigration and how densely populated a region is are weakly associated with loneliness. This is not in line with the expectations by Yang & Victor (2011), who expected an effect of migration within a country on the level of loneliness. One possible explanation of this inconsistency is that the regional level is too aggregated. That is, in order to investigate the association between population density and loneliness we must look at smaller geographical units than regions.

Glymour (2014) highlights the importance of government policies for population health. Our analysis identifies a range of upstream contextual determinants that may inform policymakers when looking at possible ways to either prevent or alleviate late life loneliness. If the link between the two QoDs and wealth determinants and loneliness is causal, then policies aimed at improving for example the safety and wealth of an area might offset loneliness levels besides other benefits of such policies. Thus, such policies could have a wider range of health benefits compared to more specific individual targeted policies. This should be investigated further by future research.

Among the strengths of our study is the data source, which has the same measures collected in the same time-period from a variety of countries with different cultural, political and economic systems. The use of multilevel modelling further gives rise to a more rigorous investigation of both country- and regional level determinants for individual loneliness in the same model. Further, instead of dichotomizing the loneliness measure and thus losing information we modelled the entire ordinal four-category score. The
selection of country- and regional level determinants was driven primarily by suggestions from the literature and availability from the data. In the selection of determinants, the focus was on selecting determinants from a range of different fields. However, research into contextual determinants of individual loneliness is still new and it is possible that important contextual determinants have been omitted from this study. Furthermore, while the effect sizes on several of our included determinants were substantial, it is challenging to isolate the mechanisms through which they work. While we have suggested a possible explanation, deeper theoretical considerations are needed to go further into explaining the mechanisms. While the data source encompasses a wide variety of European countries, further studies must investigate whether the found associations also hold for other parts of the world and potentially for other age groups.

This study focuses solely on contextual determinants of late life loneliness in order to explain cross-national differences in loneliness. Thus, it remains an open question whether contextual determinants condition the effects of individual level determinants as suggested in the literature (Dykstra 2009). Having opened wider the door for research on contextual determinants on loneliness, we leave this important question for future investigation.

**Conclusion**

Alleviating late life loneliness is an important aspect of ensuring healthy ageing. This study provides evidence that the consideration of regional as well as country determinants of late life loneliness improves our understanding of contextual determinants of loneliness. The most important predictors of loneliness are the level of freedom and equality in a country followed by the wealth of the specific regions. Based on this, the previous focus on culture as the sole determinant of variations in loneliness across countries is questioned. Thus, it seems that the context in which we live in terms of safety, freedom and wealth are strongly negatively related to the likelihood of feeling lonely when we get older. Using the biological approach to ageing, we propose that individuals residing in places with more deprivation and instability
are more likely to feel lonely because of an unconscious higher reliance on the group in order to survive compared to places with more security, stability and wealth. This analysis opens for the suggestion that when creating policies to alleviate late life loneliness and thus improving both the quality of life and health of the elderly, improving contextual country- and regional level determinants might be more effective compared to smaller and more individual-targeted policies. Comparing the effectiveness of policies targeted at the individual versus the contextual level should be a focus for future research.

**Ethics approval**

The data used in this study is from the European Social Survey (ESS). The ESS ERIC subscribes to the Declaration on Ethics of the International Statistical Institute

**Declaration of contribution of authors**

LE had the idea for the study and was the main author of the manuscript. LE and JW processed the data, carried out the statistical analysis and JW was a contributing author. Both authors have revised the text critically for intellectual content and have read and approved the final manuscript.

**Statement of conflict of interest**

The authors state no conflict of interest

**Acknowledgements**

The authors would like to thank the social relationship networks group in London for their helpful comments on an earlier draft of this paper. Parts of this study are based upon the results used for a master thesis completing a Master in Social Science Data Analysis at the University at Essex.
References


Bivand, R.S., 2015. classInt: Choose Univariate Class Intervals.


Company.


Christiansen, J., Larsen, F. & Lasgaard, M., 2016. Do stress, health behavior, and sleep mediate the association between loneliness and adverse health conditions among older people? Social Science & Medicine, 152(3), pp.80–86.


ESS Round 6: European Social Survey Round 6 Data, 2012. Data file edition 2.1,

Europan Social Survey Round 6, 2014. Weighting European Social Survey Data,


Mazerolle, M.J., 2015. AICcmodavg: Model selection and multimodel inference based on (Q)AIC(c).


R Core Team, 2015. foreign: Read Data Stored by Minitab, S, SAS, SPSS, Stata, Systat, Weka, dBase, ...


Stekhoven, D.J., 2011. *Using the missForest Package*,


Urbanek, S., 2015. rJava: Low-Level R to Java Interface.


Figure 1. Mean levels of loneliness across countries and regions within Europe (weighted)
Figure 2. Random Effects for regions (left) and countries (right)
Figure 3. Country-level characteristics
Figure 4. Regional-level characteristics
Figure 5. Unconditional model-averaged estimates

Notes: Model-averaged estimates with standard errors in parentheses. Estimates are surrounded by 95% confidence intervals. The details of model-averaged parameters are explained in Burnham and Anderson (2004) and are computed using the R-package AICcmodavg (Mazerolle 2015).
Table 1. Modelfit and AICc differences for a two-level (country) and a three-level (regions & country) cumulative logit mixed model

<table>
<thead>
<tr>
<th>Model</th>
<th>Number of parameters</th>
<th>AICc</th>
<th>ΔAICc</th>
<th>AICc weight</th>
<th>Loglikelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country+region</td>
<td>5</td>
<td>19676.60</td>
<td>0.00</td>
<td>0.94</td>
<td>-9833.299</td>
</tr>
<tr>
<td>Country</td>
<td>4</td>
<td>19681.98</td>
<td>5.38</td>
<td>0.06</td>
<td>-9836.989</td>
</tr>
</tbody>
</table>
# Table 2. Variance components and model fit for empty and base model

<table>
<thead>
<tr>
<th></th>
<th>Empty Model</th>
<th>Base Model (I)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variance components</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country</td>
<td>0.457</td>
<td>0.142</td>
</tr>
<tr>
<td>Region</td>
<td>0.026</td>
<td>0.023</td>
</tr>
<tr>
<td><strong>Model fit</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AICc</td>
<td>19677</td>
<td>14685</td>
</tr>
<tr>
<td>Difference in AICc from basemodel</td>
<td>4992</td>
<td>-</td>
</tr>
<tr>
<td><strong>Threshold</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None or almost none of the time</td>
<td>Some of the time</td>
<td>0.439</td>
</tr>
<tr>
<td>Some of the time</td>
<td>Most of the time</td>
<td>2.037</td>
</tr>
<tr>
<td>Most of the time</td>
<td>All or almost all of the time</td>
<td>3.128</td>
</tr>
</tbody>
</table>


Table 3. Log odds (SE) and exact p-values for standardized country- and regional level determinants.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Country level determinants</th>
<th>Regional level determinants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1*+Gini Coefficient</td>
<td>1*+Health Expenditure</td>
</tr>
<tr>
<td>Country</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gini Coefficient</td>
<td>0.16 (0.08)</td>
<td>3.4e-02</td>
</tr>
<tr>
<td>Health Expenditure ( % of GDP)</td>
<td>-0.26 (0.07)</td>
<td>8.9e-05</td>
</tr>
<tr>
<td>Culture - Individualism</td>
<td>-0.15 (0.09)</td>
<td>7.3e-02</td>
</tr>
<tr>
<td>QoD - Control</td>
<td>-0.19 (0.07)</td>
<td>9.46e-03</td>
</tr>
<tr>
<td>QoD - Freedom</td>
<td>-0.30 (0.06)</td>
<td>2.0e-07</td>
</tr>
<tr>
<td>QoD - Equality</td>
<td>-0.30 (0.06)</td>
<td>3.54e-07</td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
</tr>
<tr>
<td>log(Regional density)</td>
<td>0.00 (0.04)</td>
<td>9.8e-01</td>
</tr>
<tr>
<td>log(Net immigration)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>log(GDP pr. Inhabitant)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variance component</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country</td>
<td>0.118</td>
<td>0.077</td>
</tr>
<tr>
<td>Region</td>
<td>0.022</td>
<td>0.023</td>
</tr>
<tr>
<td>Model fit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AICc</td>
<td>14683</td>
<td>14675</td>
</tr>
<tr>
<td>Δ AICc (best)</td>
<td>14.50</td>
<td>6.59</td>
</tr>
<tr>
<td>AICc weight</td>
<td>0.00</td>
<td>0.02</td>
</tr>
</tbody>
</table>

*1 denotes the base model with all individual level confounders; n=10166.