**Dementia across local districts in England 2014-2015**

Short title: Dementia across local districts in England 2014-2015

Gindo Tampubolon, James Nazroo, John Keady, Neil Pendleton*

*Division of neuroscience and experimental psychology
University of Manchester
Oxford Road Manchester M13 9PL
neil.pendleton@manchester.ac.uk

Abstract

**Background:** The number of older people needing dementia care is projected to rise rapidly, and local districts are now charged with responding to this need. But evidence on local area factors of dementia is scarce. We studied the odds of dementia prevalence and its individual risk factors enriched with area factors.

**Materials and methods:** This study analysed objectively assigned dementia prevalence in people aged 60 and over living in community in England, drawing data from the English Longitudinal Study of Ageing 2014-2015 and local districts statistics using multilevel logistic models. Dementia status is ascertained using a modified version of the Telephone Interview for Cognitive Status. A number of individual risk factors were considered including social determinants, internet use, social connections and health behaviours; two contextual factors were included: the index of multiple deprivation and land use mix.

**Results:** The prevalence of dementia by this method is 8.8% (95% confidence interval 7.7\% – 9.2\%) in older adults in England. Maps of dementia prevalence across districts showed prevalent areas. In the full model no area characteristics were significant in predicting dementia prevalence. Education, social connections, internet use and moderate to vigorous physical activity showed protective associations.

**Conclusion:** Dementia in older adults in England is largely predicted by individual characteristics, though some districts have a large share of their population with dementia. Given the health and social care costs associated with dementia, differential interventions and support to districts and to groups of individuals defined by these characteristics seem warranted.

Abstract 245 words, text 1996 words

**Keywords:** dementia, area, local councils, English Longitudinal Study of Ageing

**Key points:** The modified Telephone interview for cognitive status used in this study gives a dementia prevalence of 8.8\%, same as the rate in the US. Prevalence is distributed unevenly across local area authorities in England. Dementia in older adults in England is largely predicted by individual characteristics.
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Introduction

Some 46 million people suffered from dementia worldwide last year, with a total cost of more than US$ 800 billion. In the UK dementia may cost as much as cancer, heart disease, and stroke combined (Prince, Martin et al. 2015). Furthermore, local authorities have been tasked to deliver dementia services through Public Health England. However, evidence is scarce on how prevalence of dementia varies across local districts, and to what extent district factors predict dementia status in older residents. The goal of this study is to furnish this evidence.

If the effects impact more than the patients and their carers, the determinants likewise have been found beyond the patient, namely in the surrounding areas. The comparative Scotland – Sweden study of people aged 65 and over suggested a residual association of dementia with area characteristics (Russ et al. 2015). Further the Cambridge Cognitive Function and Ageing Study (CFAS) explored a number of area characteristics (Wu et al. 2016b). It found that land use mix had an independent protective effect on dementia risk. Another area characteristic which has been suggested to accompany higher dementia prevalence is area deprivation. If the area factors are materially linked to older people’s health, then potential interventions targeted at certain areas can be explored by local districts.

Though entirely plausible area context is rarely examined nationwide; more often studied are individual characteristics. Education and occupation have been theorised to indicate brain or cognitive reserve (Stern 2012). They confer accumulated reserve, which prevents brain pathology accumulated with ageing from becoming manifest in practice (Rusmaully et al. 2017). Beyond age and sex, other covariates of dementia risk have been noted in the literature: wealth, social connections, comorbidities, and health behaviours (Tampubolon 2015a). Wealth affords better health input such as nutrition and better health maintenance such as gym membership. Social connections afford richer and more timely information about health risk and maintenance as well as support for mental wellbeing. Ageing is characterised by multiple
organs’ impairment, increasing the likelihood of dementia with other organs’ dysfunction. Health behaviours such as physical activity have been known to confer overall health benefit in older people, although the effect of physical activity has not been demonstrated specifically in relation to dementia (Prince, Martin et al. 2015).

This study has three aims: first, to decompose variations in dementia status of older adults in England into districts and individuals. Second, to provide a national prevalence figure for dementia that yields to international comparison by using a validated measure of cognitive function. Lastly, to map distribution of dementia across districts, enabling us to discern spatial patterns of burden of dementia.

Materials and methods
The English Longitudinal Study of Ageing (ELSA) is the main resource for a nationally-representative ageing study of the English older population. The last wave was in 2014-2015 which for the first time collected dementia information using the Telephone Interview for Cognitive Status. The data are freely available from the UK Data Archive (www.data-archive.ac.uk) as study number 5050. More details of the study are given elsewhere (Marmot et al. 2003; Banks et al. 2006, 2008, 2010, 2012, 2014).

Ethics review
Ethical approval for all the ELSA waves was granted from the National Research and Ethics Committee (and its predecessor bodies) of the UK National Health Service www.hra.nhs.uk. The University of Manchester’s institutional review board has exempted this study, since it used publicly available anonymised secondary data for research.

Ascertaining dementia prevalence in the population
Dementia status was ascertained using tests from the Telephone Interview for Cognitive Status, an alternative to the Mini-Mental State Examination (Jason Brandt et al. 1988). Two constructs are possible from the tests: based on the Langa-Weir approach with a cut-off 6 to mark demented status (Crimmins et al. 2011) and the Herzog-Wallace approach with a cut-off 8 (Herzog and Wallace 1997). We chose the Langa-Weir approach which consists of these tests: immediate and delayed recall of words, serial 7s, and backward counting; the total scores range
from 0 to 27. The instrument has been validated with neurological assessments in the US (Health and Retirement Study) (Langa et al. 2017).

Area information of deprivation (index of multiple deprivation) and land use mix (Land Use Database 2010) was obtained from the Office of National Statistics (www.ons.gov.uk accessed 23 July 2017), then matched with ELSA based on local area district identifier 2011. A higher deprivation score means more deprivation, whereas a higher mix score means a more diverse environment (Shannon entropy index).

**Confounders**

We included an extensive set of confounders which were known to affect cognitive function of older Britons or used in the original validation of the tests. Demographic covariates include sex and age (60 to 89 since aged is capped at 90). Cognitive functions, like other health functions, are also shaped by social determinants of health (WHO-CSDH 2008; The Marmot Review 2010). These determinants include occupational class (three categories: managerial, intermediate and routine manual class as reference), wealth tertiles (wealthiest, middle and poorest as reference), marital status (married/union, divorced or separated and single as reference), and education (Stern 2012). Using the Internet, including browsing for information, has been found to relate to cognitive function in this sample (Tampubolon 2015a), so an indicator of internet use is included. Social connections were constructed from responses on how often on average respondents (1) meet with friends, or (2) phone them, or (3) write to them; the average ranges from 0 for never or less than once a year to 6 for three times or more a week.

Since it is widely known that risk factors for cardiovascular disease may be implicated in cognitive decline (Grodstein 2007), we also include these risk factors or cardiovascular disease status. Moreover, since comorbidities generally accompany ageing, comorbidities are also considered, covering diabetes, cancer, chronic obstructive pulmonary disease and arthritis.

Behavioural risk factors known to be effective in cross-sectional studies include smoking (current smoker and not current smoker as reference), drinking (days in a week having a drink) and physical exercise (vigorous, moderate physical exercise and sedentary as reference; according to the Allied Dunbar physical exercise scale (Skelton et al. 1996)).
Only those with complete information were retained in the analysis. Differences between the analytic (N = 5232) and excluded samples (N = 2268) were tested using \( t \) test for continuous variable and \( \chi^2 \) test for categorical variables. There were more women compared to men in both samples (\( p < 0.001 \)). The excluded sample has lower TICS scores on average but the difference is not significant (\( p = 0.99 \)); and is younger but not significantly so (\( p = 0.99 \)).

**Method**

Because ELSA respondents living in different districts constitute a multilevel sample we applied multilevel logistic model to explain dementia in terms of area and individual predictors. A baseline model was fitted with random area intercepts in order to assess the proportion of variation attributed to area and individual characteristics. The final model further added area deprivation and land use mix. All analysis was done in Stata version 14 (College Station, Texas US).

**Results**

Some key characteristics of the sample are the following: mean age is 72 years, the majority are females (56.7%), married or in union (63.5%) and nearly 30% were educated at college level. Moderate or vigorous physical activities were reported by 16.6%, social connections (meet, phone, write) were maintained every few months (2.9), and more than half have used the internet (58.6%).

The national prevalence of 8.8% (95% confidence interval 7.7% – 9.2%) masks a range of spatial variation which can be grasped from a map. We are careful not to comment on particular districts, preferring to note the variation across the country. The map on the right pane is drawn with a further adjustment to prevalence. The map increased the size of the areas where dementia prevalence are highest, according prominence to those areas with most need.

**Figure 1. Maps of dementia prevalence across local districts in England 2014 – 2015**

One way of exploring this district variation is by analysing dementia using multilevel model with individual and district characteristics (Table 1, without (left pane) and with (right
Both models showed that the odds of dementia increased by 1.05 times per year. One social determinant is effective in these older ages: education. Compared to those with lower levels of education, high school graduates had reduced odds of dementia of 35%. Education as a marker of cognitive reserve has been posited to associate with delayed manifestation of impaired cognition (Stern 2012). The other determinants of class and wealth showed no significance. This may be due to their potential effects being captured by reduced comorbidities. The number of comorbidities has a significant and positive odds ratio.

Table 1. Multilevel models of dementia

Behaviours at this life stage remain strongly associated with the risk of dementia, despite its long prodromal stage, suggesting possible beneficial modifications even at older ages. For instance older people engaging in moderate or vigorous physical activity had nearly 80% lower odds of dementia than their sedentary peers. Also, strong protective associations were found for social connections and internet use, respectively, 44% and 81%.

There were no discernible residual variations across districts once individual characteristics were considered. Moreover a richer model (with index of multiple deprivation and land use mix) brought no real change to the results.

Discussion and conclusion
Motivated by the recent devolution of health and social care in England to local authority districts we studied the variation in dementia prevalence across districts. Upon investigation the spatial variation is found not to be driven by contextual differences. Instead, dementia is primarily associated with individual risk factors.

The data revealed that of people aged 60 and older 8.8% have dementia, same as in the US (Langa et al 2016, Tampubolon et al 2017). This is higher than reported for CFAS sample (7.6%) which are older. This difference may reflect the fact that the country has more regions with residents who are less advantaged than the residents of the four regions of CFAS.

This study has a number of limitations. First, because of its cross-sectional design, no causal inference can be drawn. Second, the outcome is measured using a neuropsychological
instrument without clinical examination, no doubt due to cost concerns in a nationwide study. Nevertheless the same instrument has been validated with clinical adjudication in the US Health and Retirement Study.

Notwithstanding these limitations, there are two advantages to this study: a nationally representative design and an internationally comparable instrument. Such design helps in two ways: [1] when guarding against specific implications possibly arising from regional or otherwise limited samples, [2] when formulating nationwide policy. As another advantage, TICS as an instrument has undergone valuable calibration in the ADAMS study with its detailed clinical and neuropsychological assessment.

The null findings regarding contextual associations have some support in the literature. Even at a refined scale of local super output area, Wu and coauthors found no evidence that area deprivation matters (Wu et al. 2016b). The same study, however, noted that higher land use mix associates with lower odds of dementia. The authors suggested that communities with a higher mixture of land use enable more residents to be more engaged and physically mobile. It is possible that the observed effect of land use mix is actually due to individual physical activity which is found positive here (in contrast to Prince, Martin et al. 2015).

In short individual factors including social determinants and health behaviours largely predict older people’s dementia status. So education is important, as has been found for other health outcomes in later life (Tampubolon 2015b, a, 2016; Tampubolon and Maharani 2017). In the context of dementia education and complex occupation are often understood to confer cognitive reserve. Relatedly, the reduced odds of dementia among internet users may also be understood as enhancing cognitive reserve, as such use elicits different actions and coordinations, for instance tapping, swiping, squeezing.

The use of a validated comparable instrument facilitates international study of dementia. Further examination of the burden of dementia around the world is an eminently empirical question to serve the needs of the global ageing population.

Bibliography


Tampubolon G (2015b) Delineating the Third age: Joint models of older people’s quality of life and attrition in Britain 2002-2010.


Table 1. Multilevel models of dementia: without (left) and with (right) district characteristics

<table>
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* $p<0.05$, † $p<0.01$

Figure 1. Maps of dementia prevalence across local districts in England 2014 – 2015: left: choropleth map, right: cartogram adjusted for prevalence