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Disabilities moderate the association between neighbourhood urbanity and cognitive health: Results from the Irish longitudinal study on ageing

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ABSTRACT

Background: Geographical variations in cognitive health have been extensively explored, but the evidence on adult individuals with disabilities is inconclusive. While urban living is suggested as more cognitively stimulating than rural dwelling in epidemiological research, both rurality and urbanity can present barriers that may negatively impact cognitive health, the former due to limited accessibility to stimulation, and the latter because presenting environmental stressors.
Objective: To bridge this gap in the literature, we investigated geographical variations in multiple cognitive skills in adult age based on neighbourhood urbanity and having disabilities.
Methods: Data on global cognition, memory, speed of processing and executive functions, as well as reported functional limitations, was taken from 4127 individuals aged 50 + participating in the first wave of The Irish Longitudinal Study on Ageing (TILDA). Neighbourhood urbanity was measured using Census data on population density. Multivariate regression analyses controlled for socio-demographic, health and lifestyle covariates.
Results: Residence in medium-high densely populated areas was significantly associated with better cognitive performance across all measures, after controlling for covariates. However, having disabilities was linked to worse global cognitive functioning (MoCA, $p = .005$), immediate recall ($p = .022$) and executive functions (CTT2, $p = .009$) in the least and most densely populated areas.
Conclusions: Living in urbanised areas may provide more mental stimulation than rural places; however, functional limitations moderate this association, suggesting potential environmental challenges both in rural and urban areas. Considering both individual and environmental circumstances can enrich investigations of geographical variations in cognitive health.

Introduction

Increasing ageing and urbanisation worldwide have informed accumulating evidence on how lived environments contribute to health inequalities in ageing, and on the environmental factors that can sustain healthy and independent living, defined as "age-friendly".[1–3] Along age-friendly initiatives, there is growing interest in investigating which places are supportive of cognitive health in ageing, or "cognitive-friendly",[4,5] given rising rates of dementia and cognitive impairment experienced in older age[6] and the evidence that stimulating and enabling environments can protect against cognitive decline.[7,8]

Considering a "person-environment fit" perspective[9] ageing comes with higher dependency on the level of support received from the surrounding environment, especially if experiencing disabilities. Adult individuals with functional limitations are in fact more at risk than others of facing environmental barriers and limitations to the engagement in outdoor activities[10,11] - a well-established protective factor for cognitive health in ageing[12] -, and are thus more susceptible than others to the presence of supportive and accessible places to age well. Despite rising proportions

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of individuals with disabilities worldwide,[13] it is yet unclear how the lived environment contributes to health inequalities for adult people with disabilities,[14] especially in relation to geographical variations in cognitive health.

Several epidemiological studies have indicated a cognitive advantage of living in urban rather than rural areas.[5,15–17] However, the moderating role of disabilities has been investigated in very few studies. These have shown that on one hand rural living can impact negatively on health because of geographical isolation and limited accessibility to resources,[18,19] but on the other hand, an overcrowded urban environment presents stressors and barriers (e.g., noisy traffic) that can cause withdrawal from outdoor activities.[20,21] In line with these studies, investigations looking at the proximal environment of residence suggest a nonlinear association between neighbourhood urbanity and cognitive outcomes in older age, for instance in terms of residential density,[22] or land-use mix.[23] Going beyond a cognitive focus, a study in Scotland found a nonlinear association between population density and suicide rates,[24] suggesting a detrimental effect on mental health of living in areas with very low or very high levels of urbanisation.

These findings support ecological models of ageing[9] and theories of environmental design[25] which suggest that the level of stimulation coming from the surrounding environment has to be within a certain "optimal" range in order to promote adaptive cognitive responses, especially if functional limitations make us more susceptible to environmental demands. From a cognitive, information-processing viewpoint, an older person living in a more urbanised area is exposed to a more dynamically complex environment which stimulates cognitive skills that deal with novelty,[7] multi-tasking, and making sense of complex perceptual information.[5,22,26] On the other hand, animal and human studies suggest that overpopulation and crowding are associated with reduced cognitive control and impaired spatial memory because increasing distractibility and mental fatigue.[27–29] Within this perspective, low levels and, on the opposite, very high levels of urbanisation should be the least supportive of cognitive functioning, the former being not stimulating enough, whereas the latter potentially overloading and cognitively detrimental,[25,26] especially for an individual with limited functionality.

The present study tested this nonlinear association between urbanity and cognitive health by exploring geographical variations in multiple measures of cognition for a nationally representative sample of adult individuals based on neighbourhood urbanity, and by examining the moderating effect on such variations of having a disability.

Based on the literature discussed above, we hypothesised better cognitive performance for medium-high levels of neighbourhood urbanity, whereas we expected worse performance for very low or very high levels. We also predicted this nonlinear pattern of variation to be exacerbated by the presence of disabilities.

Methods

Participants

The sample for this study included 4127 community-dwelling Irish people aged 50 and older who completed a physical and cognitive health assessment in the first wave (2009–2011) of The Irish Longitudinal Study on Ageing (TILDA), a large cohort study on the health, well-being and socioeconomic circumstances of Irish older people.[30,31] Ethical approval was obtained before data collection, and all respondents provided signed informed consent[31]; no individuals with severe cognitive impairment took part in the First Wave.[32] Further details on the design and methodology of TILDA, as well as the comparability with other longitudinal studies are available elsewhere.[32,33]

Design

Cross-sectional analyses were conducted on variations in performance for a comprehensive set of cognitive skills based on neighbourhood urbanity, and in interaction with the presence of disabilities, while controlling for individual-level covariates. An anonymised released version of the dataset for the first wave of TILDA (see http://www.ucd.ie/issda/data/tilda/) was used to maintain data confidentiality.

Measures

Neighbourhood urbanity

Neighbourhood urbanity was measured in terms of population density of the electoral division of residence of each TILDA participant as derived from the Irish Census 2006.[34] Population density was defined as the average number of inhabitants per hectare (1 hectare is equivalent to 2.47 acres). Electoral divisions were the smallest legally defined administrative areas in Ireland with an average size of 20 km^2 (or 2000 hectares). For reasons of anonymity, the variable was categorised in six groups of increasing population density adopting categories used in the Irish Census:

(1) Very low: Less than 0.5 persons per hectare (i.e., less than one person every two hectares);
(2) Low: Between 0.5 and 1 person per hectare;
(3) Medium Low: Between 1 and 10;
(4) Medium High: Between 10 and 25;
(5) High: Between 25 and 50;
(6) Very High: More than 50 persons per hectare.

By matching the above categories with broad urban-rural classifications provided in the Irish Census, we found that over 98% of participants in rural settlements (defined in the Irish Census as having fewer than 1500 inhabitants) lived in electoral divisions with very-low to medium-low population density (Groups 1–3), whereas 92% of urban participants (i.e., living in settlements with a population of 200,000 or more) resided in electoral divisions with medium-high to very-high population density (Groups 4–6). Participants living in settlements with a population going from 1500 to less than 200,000 inhabitants (an intermediated category provided by the Census) were instead more spread across electoral divisions of varying population density, although 74% lived in areas with medium-low to high population density (Groups 3–5). A detailed account of the distribution of electoral divisions by urban-rural Census categories is presented in Supplementary Table 1.

It is to note that the adopted categorisation of neighbourhood urbanity is relative to the Irish context, which has a high number of settlements with low and very low population density, and very few highly populated areas.

Disabilities

Participants were asked to report whether they experienced issues with abilities of daily living (ADLs) and/or with instrumental abilities of daily living (IADLs). These are commonly used measures of functional status: ADLs include the basic tasks of everyday life, such as eating, bathing, dressing, toileting, and walking, whereas IADLs are the activities needed to live independently in a community setting, such as managing money, shopping, using the telephone, housekeeping, preparing meals, and taking medications correctly.[31] Given that 89% ($N = 3712$) of our sample reported no disabilities (either in ADLs or IADLs), we coded the responses

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