

Built, Natural, and Social Urban Environments and Cognitive Aging in Europe

Daniela Weber ^{a,b}

^a Population and Just Societies, International Institute for Applied Systems Analysis (IIASA), 2361 Laxenburg, Austria

^b Health Economics and Policy Division, Vienna University of Economics and Business, Welthandelsplatz 1, 1020 Vienna, Austria

Abstract

Population aging and urbanization are reshaping later life in Europe. Understanding how urban environments affect cognitive health is crucial for promoting healthy aging. This study examines associations between built, natural, and social dimensions of urban environments and cognitive functioning among older adults across European cities.

We use longitudinal data from seven waves of the Survey of Health, Ageing and Retirement in Europe (SHARE, 2004–2019), covering roughly 100,000 observations of adults aged 50+ living in big cities or suburbs. Episodic memory is measured via immediate and delayed 10-word recall (range 0–20). Urban environmental indicators such as access to services and public transport, green space, air pollution, heat exposure, safety, and social inclusion are linked to respondents using Functional Urban Area (FUA) codes and survey year, drawing on EEA, Copernicus Urban Atlas, Eurostat, and OECD data.

We estimate random-intercept growth curve models, with repeated observations from individuals nested within FUAs, and countries. Models first examine each environmental dimension separately, then jointly; gender-stratified analyses and interaction terms assess heterogeneity. Sensitivity checks explore alternative model specifications and temporal alignment of exposures.

Preliminary results show negative associations of air pollution (PM₁₀, PM_{2.5}) with episodic memory and positive associations of social inclusion with cognitive functioning. These findings suggest that both physical and social urban environments shape cognitive aging trajectories. By linking population aging, urbanization, and environmental health, this study highlights spatial inequalities in cognitive health and informs the design of age-friendly, cognitively supportive cities across Europe.

Introduction

Urban areas provide older adults with better access to healthcare, social services, cultural activities, and transport infrastructure. At the same time, they expose residents to environmental stressors such as air and noise pollution, heat islands, and social exclusion (OECD, 2015; Duminy et al., 2023). These factors can have cumulative effects on health, including cognitive health, particularly for vulnerable groups such as older adults. Environmental exposures may influence vascular and inflammatory processes linked to brain aging, while the built and social environments shape mobility, social interaction, stress, and opportunities for cognitive engagement (Livingston et al., 2020).

Previous research has shown that individual characteristics such as education, age, and health behaviors are associated with episodic memory (Engelhardt et al., 2008; Nisbett, 2009). Additionally, contextual and societal conditions, including regional development and social inequality, have been identified as relevant determinants of cognitive functioning in later life (Breda et al., 2018; Weber et al., 2014). However, the role of environmental factors (i.e. built, natural, and social indicators) remains an under-investigated dimension in understanding cognitive aging (Ailshire & Clarke, 2015; Delgado-Saborit et al., 2021). Although evidence on environmental determinants of cognitive aging is growing, findings remain fragmented. Several studies have found that proximity to green space, higher walkability, or access to public amenities are associated with better cognitive performance or slower decline (Wu et al., 2015; Cadar et al., 2018; Besser et al., 2017). Conversely, exposure to air pollution, noise, or urban deprivation has been associated with poorer cognitive functioning (Power et al., 2011; Tonne et al., 2021). Yet much of the existing evidence is cross-sectional, focuses on single exposures, and rarely examines European metropolitan contexts using harmonized longitudinal data.

This study addresses this gap by combining longitudinal SHARE data with harmonized urban environmental indicators. It examines the relationship between built, natural, and social urban environmental characteristics and cognitive functioning among older adults in European cities and metropolitan regions, highlighting how environmental quality may shape cognitive trajectories. The study contributes to demographic research by integrating population aging, urbanization, and health frameworks and by emphasizing spatial inequalities in aging within and across Europe.

Data and Variables

We used data from seven waves of the Survey of Health, Ageing and Retirement in Europe (SHARE), a representative cross-national longitudinal survey of individuals aged 50 and older in participating European countries (Bergmann et al., 2019; Börsch-Supan et al., 2013). SHARE provides detailed information on socioeconomic characteristics, cognitive status, and

geographical location, making it particularly suitable for this study. The study sample is derived from seven out of eight SHARE waves (those containing geographical identifiers), covering the period from 2004 to 2019 and excluding Wave 3 (2008/2009), which focused on life-history data and does not include the variables of interest. Additionally, we excluded respondents younger than 50, those not living in a big city or the suburbs of a big city, and those with missing data on cognitive functioning. The final sample consists of approximately 100,000 person-wave observations.

Cognitive functioning is measured using an episodic memory test, in which participants are asked to recall (immediately and with delay) as many nouns as possible from a list of 10 read-out words. Episodic memory declines relatively early and exhibits heterogeneity across individuals and is therefore widely accepted as an important indicator of healthy and sustainable aging (Herlitz & Rehnman, 2008; van Rossum et al., 2010; Weber et al., 2014). We use the total memory score, calculated as the sum of correctly recalled words in the immediate and delayed recall tests (range: 0–20), with higher values indicating better cognitive functioning.

Urban environmental indicators such as access to public transport and services, green space, air pollution, heat exposure, safety, and social isolation were retrieved from the European Environment Agency and Copernicus Land Monitoring (Urban Atlas), Eurostat (Urban Statistics), and the OECD (Regions and Cities at a Glance).

Each SHARE observation was matched with the corresponding urban environmental indicators by Functional Urban Area (FUA) code and survey year. The FUA code was identified for each SHARE respondent based on degree of urbanization and NUTS3 information. Observations with only NUTS1 or no NUTS information were excluded due to insufficient spatial precision.

In addition, we included individual-level covariates identified in the literature, including demographic and socioeconomic characteristics.

Analytical Strategy

We use random-intercept growth curve models to examine the longitudinal association between urban environmental indicators and cognitive functioning. Given the hierarchical structure of the data, we specify a three-level model with repeated observations nested within individuals (level 1), individuals nested within Functional Urban Areas (level 2), and FUAs nested within countries (level 3). This structure accounts for within-person change over time and between-area variation.

We adopt a sequential adjustment strategy. First, we estimate models including each environmental dimension separately (built, natural, and social). We then include all three dimensions simultaneously to assess whether any dimension exerts a dominant influence on cognitive functioning. We further conduct gender-stratified analyses and include interaction terms between gender and environmental indicators to explore gender-specific associations.

To assess the robustness of the findings, we estimate alternative model specifications and include different combinations of control variables, including socioeconomic and health-related covariates. We also test alternative temporal alignment assumptions for environmental measures in sensitivity checks.

Preliminary Results

Descriptive analyses illustrate the spatial distribution of average memory scores across Europe over time (Figure 1). Beyond individual-level differences, there are notable geographical variations in cognitive performance.

Preliminary growth-curve regression results indicate significant negative associations between natural urban environment factors (i.e. PM₁₀ and PM_{2.5}) and episodic memory for both men and women. In contrast, social urban environment factors, such as social inclusion, are positively associated with cognitive functioning. These findings suggest that both environmental exposures and social context contribute to differences in cognitive aging across European cities.

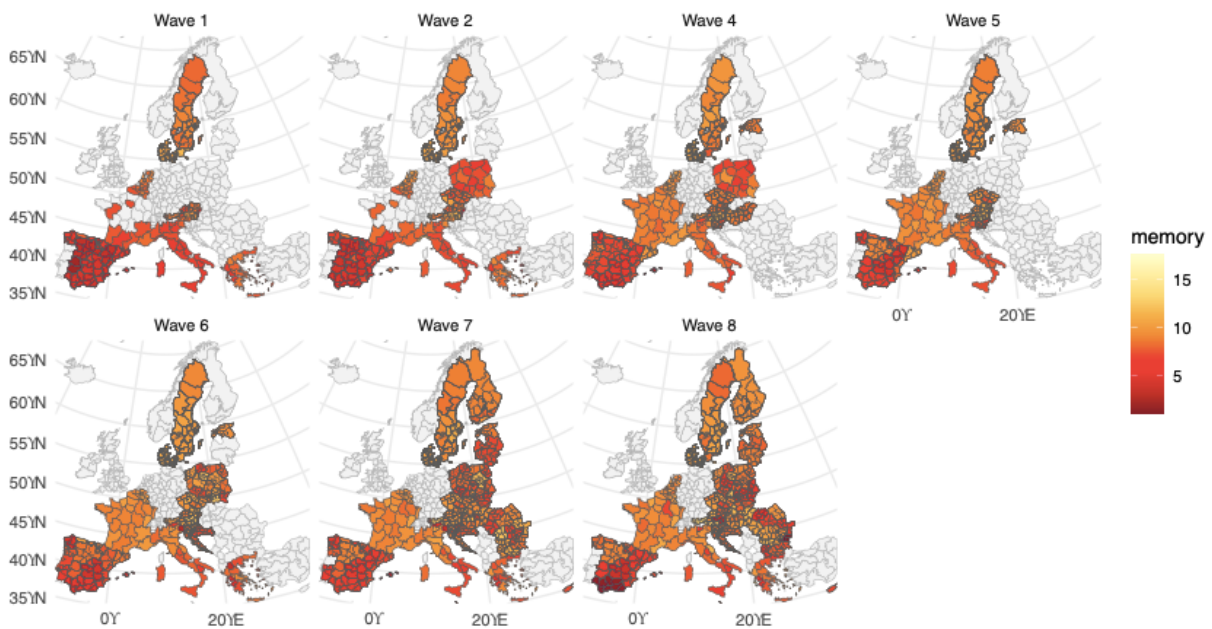


Figure 1: Average episodic memory scores across European regions by survey wave

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