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The influence of socioeconomic, biogeophysical and built environment on old-age survival in a Southern European city

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ABSTRACT

Old-age survival is a good indicator of population health and regional development. We evaluated the spatial distribution of old-age survival across Porto neighbourhoods and its relation with physical (biogeophysical and built) and socioeconomic factors (deprivation). Smoothed survival rates and odds ratio (OR) were estimated using Bayesian spatial models.

There were important geographical differentials in the chances of survival after 75 years of age. Socioeconomic deprivation strongly impacted old-age survival (Men: least deprived areas OR = 1.31(1.05–1.63); Women OR = 1.53(1.24–1.89)), explaining over 40% of the spatial variance. Walkability and biogeophysical environment were unrelated to old-age survival and also unrelated to socioeconomic deprivation, being fairly evenly distributed through the city.

1. Introduction

Today, 52% of the world population, 76% of Europeans, and 63% of the Portuguese resides in urban areas (WB, 2014). For decades, urbanization was thought as synonymous with human development and health (Stephens, 1996). However, recent studies have shown these settings hold important inequalities and harmful exposures (Vlahov et al., 2007; WHO/UN-HABITAT, 2010).

Residential segregation by socioeconomic position, race and ethnicity, can be observed in most urban settings (Kramer and Hogue, 2009). Residential segregation refers to the spatial separation of social groups within a certain geographical area (Massey and Denton, 1988). This socio-spatial process causes important environmental differences between neighbourhoods. For instance, affluent neighbourhoods are more likely to attract health-promoting amenities, such as healthy food shops, exercise facilities, services, commerce or cultural spaces, and to exclude hazards, such as pollutant industries or heavy traffic roads (Nogueira, 2010; Stephens, 1996; Woolf and Aron, 2013). Together with socioeconomic deprivation, social fragmentation and isolation represent another negative feature of urban living. But, evidence exists that living in a walkable and mixed use neighbourhood might counteract these problems by improving social capital and by encouraging pedestrian use of streets (Hanibuchi et al., 2012; Leyden, 2003).

Urban residents are also generally exposed to poorer physical

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environments than their rural counterparts (Burkart et al., 2015; Marzluff et al., 2008; Vlahov et al., 2007) – high pollution levels, lack of natural greenspace, and frequent temperature extremes. All these influences have well-documented consequences for the health and survival of the populations (Burkart et al., 2015; Hajat et al., 2007; Shumake et al., 2013; Takano et al., 2002).

The social and environmental polarization that occurs in urban settings creates the 'perfect' circumstances to produce health inequalities between neighbourhoods in mortality and life expectancy, as numerous studies have found (Borrell et al., 2014; Diez Roux et al., 2004; Domínguez-Berjón et al., 2010; Gotsens et al., 2013; Hoffmann et al., 2014; Mari-Dell'Olmo et al., 2015). Some of these studies have also observed that, although inequalities are universal, their magnitude varies greatly from setting to setting and seem to be considerably smaller in southern European cities than in other places in Europe (Borrell et al., 2014; Gotsens et al., 2013; Hoffmann et al., 2014; Mari-Dell'Olmo et al., 2015). This is thought to be the result of differences in social pattering of health-related behaviours (Mackenbach et al., 2008; Mari-Dell'Olmo et al., 2015) Studies that have looked at the variations in health within Portuguese urban settings have been restricted to the capital city, Lisbon (Borrell et al., 2014; Gotsens et al., 2013; Hoffmann et al., 2014; Mari-Dell'Olmo et al., 2015; Santana et al., 2015), and none of these studies have specifically addressed life expectancy and mortality of the eldest. Gains in life expectancy are currently driven by increases in old-age survival (Kannisto, 2000; Mathers et al., 2014). Therefore, old-age survival represents an important indicator of population health at the current stage of the epidemiological transition. Moreover, there are reasons to believe older populations might be particularly vulnerable to the characteristics of their immediate residential environment: climate extremes and air pollution have starker effects on the oldest (Hajat et al., 2007); older people might more frequently interact in the context of the neighbourhood; and might be more dependent on their local resources (shops, services, healthcare, recreation) (Diez Roux et al., 2004).

The fact that urban settings hold a variety of realities in a relatively small area makes them the ideal place to study and monitor health inequalities, and to implement actions against them. Moreover, because cities are human-designed places, constantly under construction, the identification of health inequalities and their causes may be able to support a health policy response by the municipal governments (Collins and Hayes, 2010).

Therefore, the aim of this study is to describe the spatial inequalities in old-age survival across the second most important urban area of Portugal, Porto, and to evaluate the role of socioeconomic and physical environmental factors in shaping those patterns. With that intent, three composite indicators will be used: the European Deprivation Index, to characterize the socioeconomic status of the neighbourhoods; the physical environmental deprivation index, to characterize biogeophysical environment (climate, pollution and greenness); and the walkability index to characterize the built environment in terms of availability and accessibility of destinations. The relations between these indicators will be explored too, so we will assess whether or not people resident in deprived areas are exposed to more detrimental physical environments.

2. Methods

2.1. Study area

Porto municipality is located in the northwest of Continental Portugal and comprised approximately 238,000 inhabitants in 2011 (INE, 2011), distributed across 41.7 km^2.

Porto is limited by the Atlantic coast, and extends along the Douro River estuary. It is an industrial and port town within the Porto Metropolitan Area, the second largest metro area of Portugal with roughly 1.3 million inhabitants.

2.2. Outcome

Life expectancy and mortality data at old ages in Portugal are not available at neighbourhood level and even if they could be obtained estimating life expectancy for such small areas comes with well-documented problems – large standard errors and overestimation of life expectancy after 85 and 95 years of age (Eayres and Williams, 2004; Scherbov and Ediev, 2011).

Therefore, we had to derive a measure of old-age survival ($r_i = \frac{y_i}{n_i}$) that expresses the probability of people aged 75–84 years surviving for an additional ten years, i.e., surpassing the average life expectancy (Ribeiro et al., 2016). Where r_i is a ten-year survival rate, $i=1,\ldots,109$ denotes area, the variable y represents the population aged 85–94 years old in 2011 and n the population aged 75–84 years old ten years before, in 2001.

2.3. Neighbourhoods

Population data for the above mentioned age groups was only available at census block group (CBG) level. As most covariates dated back to 2001, we used 2001 CBG as the geographical unit (n=413; average population of 637 inhabitants). However, due to the boundary's changes of CBG between 2001 and 2011 and the presence of areas with very few or no residents aged 85–94 years in 2011, we aggregated the areas into 109 'super' CBG, which became our final units of analysis, from now on simply referred to as neighbourhoods. This aggregation strategy meant each neighbourhood held an average of 30 and 70 inhabitants, for the age groups 85–94 and 75–84 respectively.

CBG areas were combined to form the neighbourhoods using the SKATER algorithm (Spatial 'K'luster Analysis by Tree Edge Removal) (Assunção et al., 2006), implemented in R package 'spdep'(Bivand, 2015). SKATER is a regionalization approach that partitions a minimum spanning tree through a tree edge-removal procedure that focuses on edges with high dissimilarities, in this case focussing in particular upon socioeconomic deprivation differences. It allowed us to keep intact functional/natural geographical units to ensure combined areas were similar in terms of socioeconomic composition, housing typology, building style and age. This was confirmed afterwards by overlaying the new neighbourhoods with satellite imagery.

2.4. Covariates

2.4.1. Socioeconomic deprivation

The European Deprivation Index (EDI) was used to classify small areas according to their level of socioeconomic deprivation. The EDI is a transnational multivariate index developed for five European countries, France, England, Italy, Spain, and Portugal.

The EDI was constructed in three steps using both individual and area level census data. These steps are detailed elsewhere (Guillaume et al., 2015) but in brief were:

1) Construction of an individual level indicator of deprivation, based on EU-SILC (EU-Statistics on Income and Living Conditions) information;
2) Identification of variables available both at individual level (EU-SILC) and at area level (2001 national population census); and
3) Determination, at individual level, whether the set of area level variables from the census selected at step 2 were associated