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Socio-economic inequalities in tobacco-related diseases in Portugal: an ecological approach

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ABSTRACT

Objectives: The existence of socio-economic (SE) inequalities in smoking is well demonstrated, but less is known about its consequences. This study measures SE inequalities in the prevalence of tobacco-related diseases (TRD) in Portugal, using a new area-based SE indicator.

Study design: Ecological study.

Methods: In-patient data were used to identify TRD discharges at all Portuguese NHS hospitals for the year 2011. The definition of TRD incorporates malignant cancers, cardiovascular diseases, cerebrovascular diseases and respiratory diseases. We created an area-based SE indicator on the basis of census data, using factor analyses. The association between the prevalence of TRD and the SE indicators was measured using Generalized Linear Models. The spatial correlation of this indicator was assessed using variograms.

Results: Two area-based SE factors were identified at the parish level, reflecting (i) social position (education and occupation); and (ii) deprivation (overcrowding and manual occupations). Upper-social-class areas were associated with a lower prevalence of malignant cancers, cardiovascular, and respiratory diseases.

Conclusion: We found significant inequalities in TRDs across Portuguese parishes using a newly created area-based SE indicator reflecting several SE dimensions. This result emphasizes that inequalities in smoking are reflected in inequalities in health, and should be tackled through equality-oriented area-based tobacco policies.

Introduction

The literature shows that 22% of male all-cause deaths and 6% of female all-cause deaths are due to tobacco-related diseases (TRDs).[1] Also, the likelihood of survival is greater among never smokers than among ever smokers.[2] In Portugal, 11.7% of deaths and 11.2% of Disability Adjusted Life Years are attributable to smoking, with a very uneven distribution across genders, probably due to the different patterning of risk behaviours.[3,4]

Meanwhile, there is much evidence that tobacco is socially patterned,[5] related to the unequal access to information, to the unequal ability to process information and adapt

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behaviours, or to the unequal access to smoking cessation programmes.[6] If the worse-off are more likely to smoke, they are potentially more at risk of developing TRDs, and die earlier. From a theoretical viewpoint, Adler and Stewart posit that unhealthy lifestyles are a major mediating factor between SE conditions and health outcomes.[7] Using an indirect approach, Jha et al. establish this link between SE inequalities in smoking and the SE patterning of mortality.[8] In Portugal, however, the SE inequalities in smoking have emerged very recently, and, to our best knowledge, there is no evidence on the SE inequalities in tobacco-related morbidity.[4,9] This paper measures the SE inequalities in the prevalence of TRDs in Portugal using a newly created SE area-based indicator for the lowest administrative level in Portugal (parishes).

Area-based SE indicators are widely used in health since they capture several dimensions of SE status. Some well-known examples are the Townsend Index, Jarman Index, and Carstairs Index, based on census indicators.[10–12] Area-based SE indicators influence health outcomes such as mortality and cancer incidence, preterm birth and low birth weight, cardiovascular disease incidence, and several causes of death including heart disease, malignant neoplasms, and others.[13–16] From a theoretical viewpoint, SE area-based indicators are proxies for individual socio-economic status. For example, Krieger et al. concluded that single and composite area SE variables (at census tract and block group levels) provided similar information regarding mortality and cancer incidences.[13] In the absence of individual data on SE status, area-based SE indicators are useful substitutes to the usual markers of SE conditions such as education and income, whose causal effects on health have been well established.[17] Area-based SE indicators also proxy the neighbourhood conditions where people live, and the relation of these conditions with health has also been well demonstrated.[18]

Methods

Creating an SE indicator for Portuguese parishes

Census data from Statistics Portugal was used to compose an SE indicator.[19] Data refer to 4050 mainland Parishes (with an average of 2480 inhabitants) and include the following SE factors: education (percentage of people older than 15 years with no education, secondary education, and higher education), income (percentage of houses with monthly costs with acquisition higher than €500, percentage of people more than 15 years old living with guaranteed minimum income), occupation (percentage of unemployed people more than 15 years old, percentage of residents employed in intellectual, scientific, and technical occupations, industry, trade, and services occupations, industrial and manual occupations, and primary sector occupations), housing conditions (percentage of buildings more than 50 years old, percentage of buildings damaged and with great repairing needs, percentage of households with parking or garage, and percentage of overcrowded houses), and family environment (percentage of people more than 65 years old living alone).

The choice of the SE variables was guided by theoretical insights from the literature and by the availability of information. From a theoretical viewpoint, education, income, and occupation have been regarded as major influences on health conditions because they refer to 'what resources individuals hold and what sort of life chances they have' (Lynch and Kaplan, page 19).[17] According to Glymour et al., 'socioeconomic status is typically characterized along three dimensions: education, employment, and money' (page 17).[20] Education is related to future success (and thus access to economic resources and prestige), and to capacity to learning and gathering information. Occupation signals the working environment (and thus exposure to risks, including psychosocial ones), and also the income and prestige. Finally, income relates directly to the material conditions (housing, food, medical care, neighbourhood, etc.). In order to complete the relatively limited information on material resources, we added variables related to housing, which is a marker of wealth and living conditions. Also, according to the model of SE inequalities proposed by Adler and Stewart, the living conditions mediate the relationship between the SE primary indicators (education, income, and occupation) and the health outcomes.[7] The family environment also completes the picture of resources and constraints, as the family potentially provides social and material support that are beneficial for health (see also Adler and Stewart).[7]

We used factor analysis to explore the relation between variables from the 2011 Portuguese Census. Our analysis explores the correlation of a given set of variables in order to find a small number of underlying variables named principal component. The aim is to capture the shared relationships, structure, and highest percentage of the total variance of the original variables, and get other variables not as correlated with each other as the original ones.[21,22] We selected the number of components whose eigenvalue is higher than one. We then repeated factor analysis in two sub-samples selected randomly from the general sample. These analyses were performed using SPSS, version 20.

Using the indicator to characterize SE inequalities in the prevalence of TRDs

To measure the association with TRDs, we used data for all in-patient discharges at Portuguese NHS hospitals for the year 2011 (Administração Central do Sistema de Saúde [Central Administration of the Health System] – ACSS, IP.). Data on in-patient stays included 576,687 fully-comparable observations, with information on primary diagnosis, secondary diagnosis, interventions, length of stay, age, gender, and area of residence (parish). The main TRDs were selected according to Borges and Gouveia, and are listed in Table 1.[3]

We computed the prevalence rate for the selected TRDs for each parish. Then, we estimated the determinants of the prevalence rate of in-patient cases for those diseases using multivariate analyses. Given that the dependent variable was a prevalence rate, which varies between 0 and 1, we modelled this variable using a generalized estimating equation approach assuming a binomial distribution.[23] The explanatory variable was the SE indicator for the Portuguese parishes,

Table 1 – ICD 9-CM from tobacco related diseases.

Malignant cancers
140–149 – Lips, oral cavity, pharynx
150 – Oesophagus
151 – Stomach
157 – Pancreas
161 – Larynx
162 – Trachea, lungs, bronchi
180 – Cervical
189.1 – Kidney
188 – Bladder
Cardiovascular disease
410–414 – Ischaemic cardiac disease (adults 35–64 and ≥65 years old)
412–414 – Other cardiac diseases
440 – Atherosclerosis
Cerebrovascular disease
433–434 – Adults 35–64 years old
436–438 – Adults ≥65 years old
Respiratory diseases
480–487 – Pneumonia, flu
490–492 – Bronchitis, emphysema

Source: Borges and Gouveia (2009).

Table 2 – Descriptive statistics (N = 4050).

Variable	Mean	Std. deviation
Education (†)		
People older than 15 years old without schooling (%)	10.1	5.9
Population older than 15 years old with secondary education (%)	14.8	5.1
Population older than 15 years old with higher education (%)	10.3	7.4
Occupation (†)		
Residents employed in intellectual, scientific and technical occupations (%)	3.6	3.0
Residents employed in industry, trade and services occupations (%)	18.8	6.5
Residents employed in industrial and manual occupations (%).	12.8	6.5
Residents employed in primary sector occupations (%).	3.5	4.0
Residents unemployed with more than 15 years old (%).	12.5	5.3
Housing conditions (†)		
Buildings constructed before 1961 (%).	27.1	16.0
Buildings with great repairing needs or much deteriorated (%).	5.1	5.2
Households with parking or garage (%).	58.1	18.4
Dwellings (classic families) of usual residence overcrowded (%).	9.1	4.5
Wealth (†)		
Dwellings with monthly costs of acquisition equal or greater than €500 (%).	17.5	14.5
Residents with >15 years old and living mainly from guaranteed minimum income (%).	0.9	1.1
Owner occupied houses (%)	19.4	12.2
Family composition (†)		
Individuals with ≥65 years old living alone as a percentage of total individuals (%).	5.7	3.5
Prevalence of inpatient cases with tobacco-related diseases (‡)		
Malignant cancers (‰)	1.4	3.8
Cardiovascular disease (‰)	0.9	2.2
Cerebrovascular disease (‰)	0.2	0.6
Respiratory disease (‰)	2.4	5.2

Source: (†) Statistics Portugal[19] and (‡) ACSS, IP. (2011).

and the percentage of inhabitants aged more than 65. These analyses were performed using STATA statistical package.

An additional characterization of the SE indicator: spatial approach

Using census tractor zip code boundaries as a proxy for neighbourhoods may include heterogeneous populations which do not correspond to the actual context where people leave. People are not confined to physical boundaries, but move across space limits and are subject to multiple 'extra-neighbour' environments, when going to work or school, for example. Also, an area might suffer from positive or negative externalities from neighbouring areas, for example, from river pollution, or dangerous buildings in the neighbourhood. It is thus of primary importance to characterize if 'spatial continuity' exists, to evaluate if the phenomenon under analysis is local, regional, or national level. There are several methods to characterize the spatial continuity of a variable. We used the so-called variogram $\gamma(h)$, which is a graphic representation of the spatial continuity of a variable as a function of distance and direction.[24,25] The spatial analysis was conducted in GeoMS, and the maps were constructed with QGIS Development Team software.

Results

Creating an SE indicator for Portuguese parishes

Descriptive statistics for education, occupation, housing conditions, wealth, and family composition are presented in Table 2. The sample comprised 4050 observations, corresponding to the Portuguese parishes. Many variables had a correlation greater than 0.3, the Kaiser–Meyer–Olkin measure of sampling adequacy was above 0.5, and the probability associated with Bartlett's test of sphericity was lower than the significance level.[21] Thus, the data complied with the statistical assumptions required for the factor analysis procedure. From the factor analysis, we obtained two non-rotated factors, which explained 75.01% of total variance. The communalities explained more than half of each original variable's variance.

Secondary education, occupations related with industry, trade and services, and owner-occupied houses contributed positively to the first component (see Table 3). Low education contributed negatively to this first component. We called this first component 'social position'. The second component was positively correlated with manual occupations and overcrowded houses, so that we called it 'deprivation'.

From the first map in Fig. 1 we see that the highest values for social position (factor 1) were located mainly in North coastal

Table 3 – Results from principal component analysis.

Components	Factor 1st	Factor 2nd	Communalities
People older than 15 years old without schooling	**−0.81**	−0.05	0.66
Population older than 15 years old with secondary education	**0.91**	−0.24	0.88
Residents employed in industry, trade and services occupations	**0.87**	−0.31	0.86
Residents employed in industrial and manual occupations	0.40	**0.74**	0.71
Dwellings (classic families) of usual residence overcrowded	0.33	**0.70**	0.60
Owner occupied houses	**0.89**	−0.09	0.79
Eigenvalue	3.30	1.20	
Cumulative percentage of variance explained	54.97	75.01	

Note: Values with factor weights higher than 0.4 are displayed in bold.

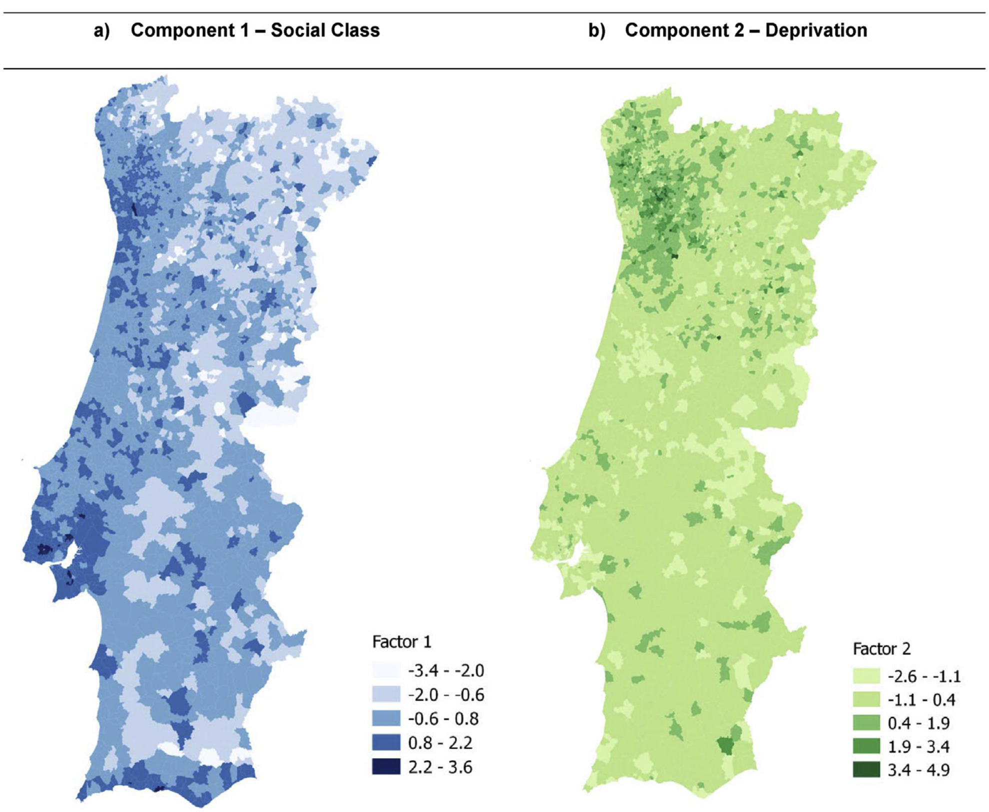
regions, in the Lisbon metropolitan area, and in Algarve. For factor 2, most shaded areas were in the Porto metropolitan area and the Alentejo region close to the Spanish border. Finally, the analysis performed in the randomly selected sub-samples gave similar results in terms of number of components and contents, and dimensions of communalities.

Using the indicator to characterize SE inequalities in the prevalence of TRDs

The results from regression analysis in Table 4. More privileged parishes experienced a lower prevalence rate of in-patient stays for three of the TRDs according to the first component (model 1), namely for malignant cancers ($\beta = -0.27$, $P < 0.001$), cardiovascular disease ($\beta = -0.18$, $P < 0.001$), and respiratory diseases ($\beta = -0.34$, $P < 0.001$). When we adjusted for the percentage of inhabitants older than 65 years (model 2) the relation remained significant for malignant cancers ($\beta = -0.32$, $P < 0.001$) and respiratory diseases ($\beta = -0.44$, $P < 0.001$), it became significant for cerebrovascular diseases ($\beta = -0.25$, $P < 0.01$), and lost significance for cardiovascular diseases. By contrast, the association was never significant for the second component when adjusting for the percentage of inhabitants older than 65 years.

An additional characterization of the SE indicator: spatial approach

The variograms are shown in Fig. 2. The component of social position (Fig. 1a) showed a spatial continuity, with 88% of the data following a geographical structure, and the spatial relationship being observed until a range of 145 km. The deprivation component had a non-negligible percentage of unexplained variance (83%) with a range of 52 km, which



Note: Maps constructed with QGIS Development Team, 2014. QGIS Geographic Information System. Open Source Geospatial Foundation Project [http://qgis.osgeo.org], using shapefiles from official administrative map of Portugal - CAOP, 2011 [http://www.dgterritorio.pt/]. Categories of indicators were based in quintiles.

Fig. 1 – Component maps.

Table 4 – Regression analysis (robust) for the prevalence of in-patient stays from tobacco-related diseases.

	Malignant cancers		Cardiovascular disease		Cerebrovascular disease		Respiratory disease	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Intercept	−7.12***	−6.99***	−7.71***	−8.14***	−9.08***	−8.53***	−6.52***	−6.26***
Social position	−0.27***	−0.32***	−0.18***	−0.03	−0.05	−0.25**	−0.34***	−0.44***
Deprivation	0.06	0.04	−0.07**	−0.01	0.15***	0.08	−0.01	−0.05
Pop >65		−0.51		1.62*		−2.09*		−0.97*
Adj. R^2	0.14	0.12	−0.01	0.12	0.03	−0.02	0.06	0.26

Significance levels: *P < 0.05, **P < 0.01, ***P < 0.001.
(1) Model only with the component factors.
(2) Model adjusted also for the percentage of inhabitants with more than 65 years old.
Adj. R^2 = Squared correlation between the observed and the predicted values.

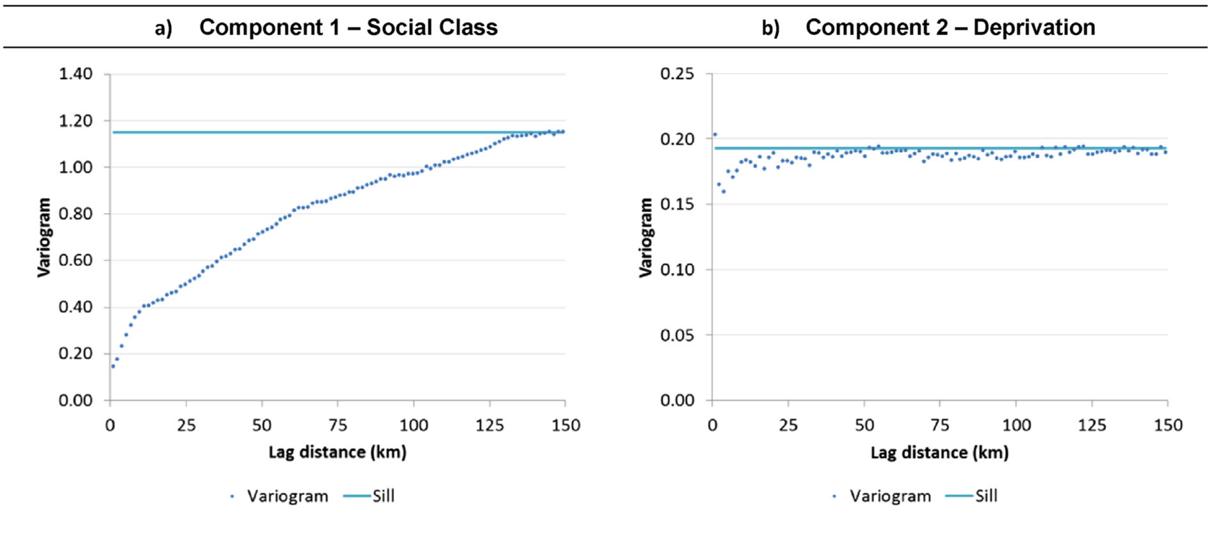


Fig. 2 – Omnidirectional variograms for the three components.

indicated that much of the data variation was not explained by a spatial continuity. The spatial continuity (for the first component) and negligible spatial continuity (for the second component) demonstrate that SE factors continue to follow a geographical pattern. Thus, the local influence using parish boundaries can be considered as appropriate.

Discussion

This study sought to measure the SE inequalities in the prevalence of TRDs in Portugal using a new SE status characterization of Portuguese parishes. We first created an SE status indicator comprising two components that gathered information on the SE position and deprivation. This indicator was very complete and comprehensive as it embraced and organized different components (education, occupation, income, housing, family context).

Associations between area-based SE indicators and TRDs were explored using an exhaustive database of in-patient stays. Lower prevalence rates of tobacco-related in-patient stays were associated with more privileged areas. These results confirmed the ones found in literature, which show that mortality from TRDs are more prevalent among the worse-off.[1] Also using area-based variables, a recent study associated poverty rate of the residential census tract with cancer linked to risk factors (as tobacco, alcohol, drug use, sexually transmitted disease, and poor diet).[26] Two mechanisms may underlie these findings. On the one hand, there is substantial evidence that smoking is more prevalent among the worse-off, related to the insufficient information or its inadequate use, to the greater financial barriers to stop smoking, and to a greater exposure to tobacco in social networks.[6] The reversal of inequalities in Portugal, with greater prevalence of tobacco consumption among the poor and less educated men, appears to be reflected in the inequalities of TRDs.[4] On the other hand, it may well be that among smokers, the better-off are less vulnerable to TRDs, for example because their lifestyle is healthier despite their smoking habits, or because they have better access to and use of medical services. By contrast, the deprivation indicator was not significantly associated to TRDs. One possible explanation is that the living environment, which is a major contributor to this indicator, may be associated with health conditions unrelated to tobacco, as asbestos-related cancers.[27]

Some limitations have to be taken into consideration. Firstly, several authors argue that composite indicators are difficult to interpret and do not permit comparisons with other studies. However, our results showed two distinct and informative factors, related with social position and deprivation, which allowed for relatively straightforward interpretations.[18] In this sense, we considered that the two components extracted from the factor analysis could be used for different purposes in public health, as tools to identify SE inequalities in health and healthcare needs. Secondly, this study did not include in-patient data from private hospitals. However, according to national statistics, in 2012 80.5% of in-patient cases were in hospitals overseen by state government.[a] Thirdly, information about other SE components such as social capital and support, income inequality, and ethnicity, were not available at the lower administrative level, used in this study. Finally, although it is useful to analyse contextual factors in order to explain health, we should not infer individual-from aggregate-level relationships, otherwise we are incurring the risk of the so-called ecological fallacy, i.e., applying conclusions from aggregates and ignoring individuality.[28]

In conclusion, we found significant inequalities in TRDs across Portuguese parishes, with lower prevalence rates of in-patient stays being associated with more privileged areas. In other terms, our paper shows that the inequalities in smoking are reflected in inequalities in TRDs, with potentially detrimental consequences on inequalities in health and mortality. On the one hand, these results reinforce the need for policies that reduce the inequalities in smoking, such as tobacco taxation or pricing.[29] On the other hand, the newly created SE indicator for Portuguese parishes underscores that inequalities were observable on a geographical basis, suggesting that the reduction of SE inequalities in tobacco could be achieved by targeting the less privileged areas.

Author statements

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Ethical approval

Not required. This manuscript does not include studies of patients, patient records, or volunteers.

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[a] INE (2014) Dia Mundial da Saúde, Destaque – Informação à comunicação social, Lisboa: INE.

Competing interests

None declared.

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