The Invisible Killer: Could Differentials in Geographical Mortality be Partially Explained by Indoor Pollution?

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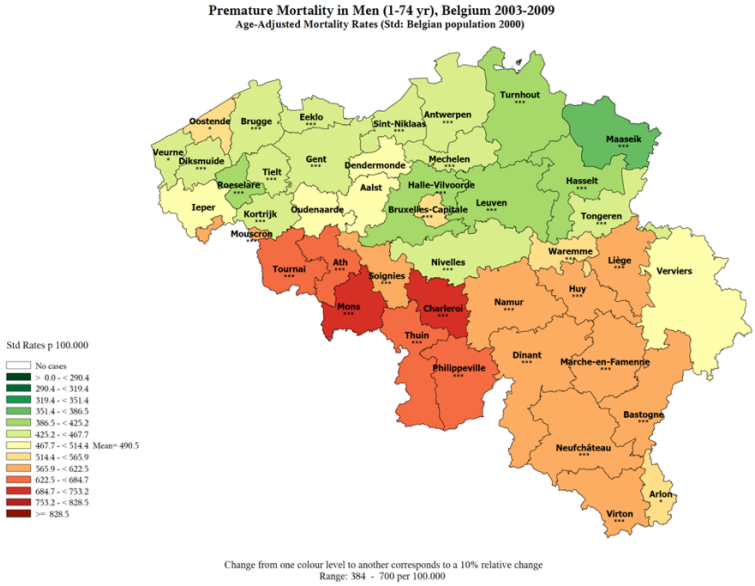
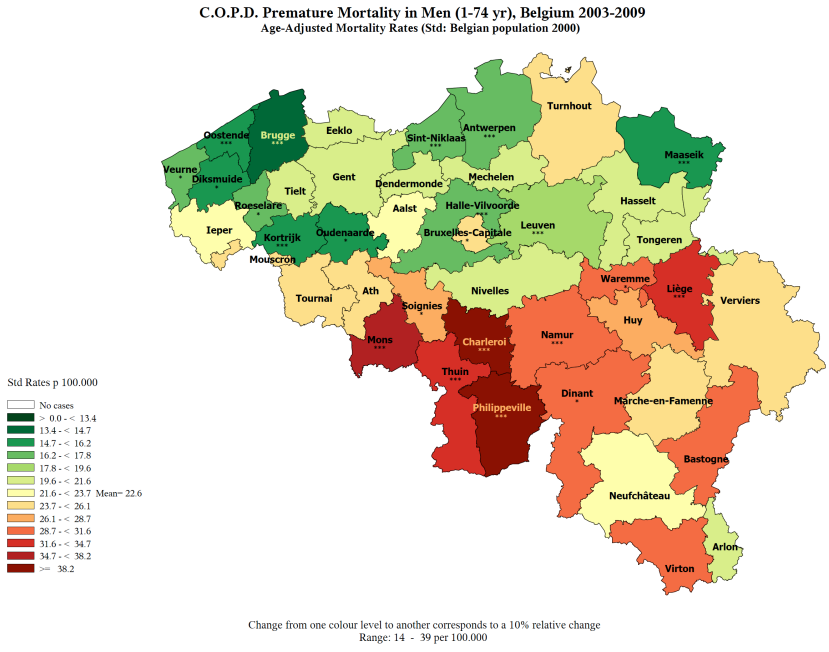
Introduction

Belgium has large regional differences in life expectancy. In 2023 life expectancy was 83.2 years in the Flemish Region and 80.6 years in the Walloon Region. Inside each region there were also important mortality differences on the level of the districts.



Cause specific mortality patterns helps to explain partially the composition of the factors contributing to these differences (Renard, Tafforeau, & Deboosere, 2015).



Socio-economic differences in the composition of the population and poverty have often been proposed to explain some disparities, but a large part of differentials in cause specific mortality remained after control for SES-factors.

According to the European Environment Agency *"air pollution remains the largest environmental health risk in Europe. Exposure to fine particulate matter and nitrogen dioxide levels above the World Health Organization recommendations cause an estimated 253,000 and 52,000 premature deaths, respectively, in 2021."*

Cardiovascular disease and respiratory diseases are most directly linked to air pollution. Both declined in recent years probably because of improving air quality and changing lifestyle (smoking and working conditions). The decrease in smoking behavior, improved air quality and new treatments and medication are among the main explaining factors for this decline. The implementation of the national Irish smoking ban resulted for instance in immediate reductions in cardiovascular, cerebrovascular, and respiratory mortality (Stallings-Smith et al., 2013). Several studies on mortality by cause, by social class and by geographical entity related to air pollution have recently been published for Belgium (Aerts et al., 2020; Bauwelinck et al., 2022). Less is known about the potential impact of indoor pollution. Data on the number of housholds involved and on the levels of dangereous indoor pollution do not exist for Belgium. Potential sources of indoor air pollution are smoking, cooking and heating, dust, and building materials. Household air pollution from solid fuel use is a significant health risk, particularly affecting respiratory and cardiovascular health (McCracken et al., 2012).
We used the type of heating to investigate the effect on respiratory and cardiovascular mortality. In 1991 according to the census 60% of the households in Belgium used a central heating system, 34% didn't and for 6% data are missing. The largest group that didn't use a central heating system used gas heaters, the second largest group a coal stove. This group still represented more than 8% of the population in 1991. Indoor household combustion of coal produces fine and ultra-fine particles and a large spectrum of other noxious chemicals (Hays, Geron, Linna, Smith, & Schauer, 2002). Around 1,5% of the population were using indoor combustion of wood another source of potential indoor air pollution (Vicente et al., 2020). Although the total number of households with indoor combustion of coal and wood was only 10%, the regional distribution was very uneven with a high concentration in some districts.

Data and methods
The census population of age 31 and older in 1991, surviving in 2001, has been linked to a mortality follow-up from 2001 till 2021. Of the 5.835.068 surviving residents 85.717 died from a chronic lower respiratory disease (ICD10: J40-J47) over a period of 20 years and 167.319 from ischemic heart disease (I20-I25). Households have been classified in four categories according to the type of heating and fuel in the 1991 census: central heating, wood burning, coal stoves and all other types of heating. We don't have information if and for how long people were still using the same type of heating after

2001, but by selecting the 30 years old we assume that most have been exposed during at least 30 years to the declared heating type before 1991.
We used a Cox regression model with the days of surviving as time variable and looked at the relative risk of dying from IHD and from COPD by type of heating controlled for sex, age, geographical area and educational level.

Results

Using a coal stove results in the highest relative mortality risk respectively 48% and 85% higher than the reference group (central heating) for ischemic heart disease and for lower chronic respiratory disease.
Controlling the impact of combustion in house for educational level has only a partial explaining effect on the relationship with ischemic heart disease and lower chronic respiratory disease.

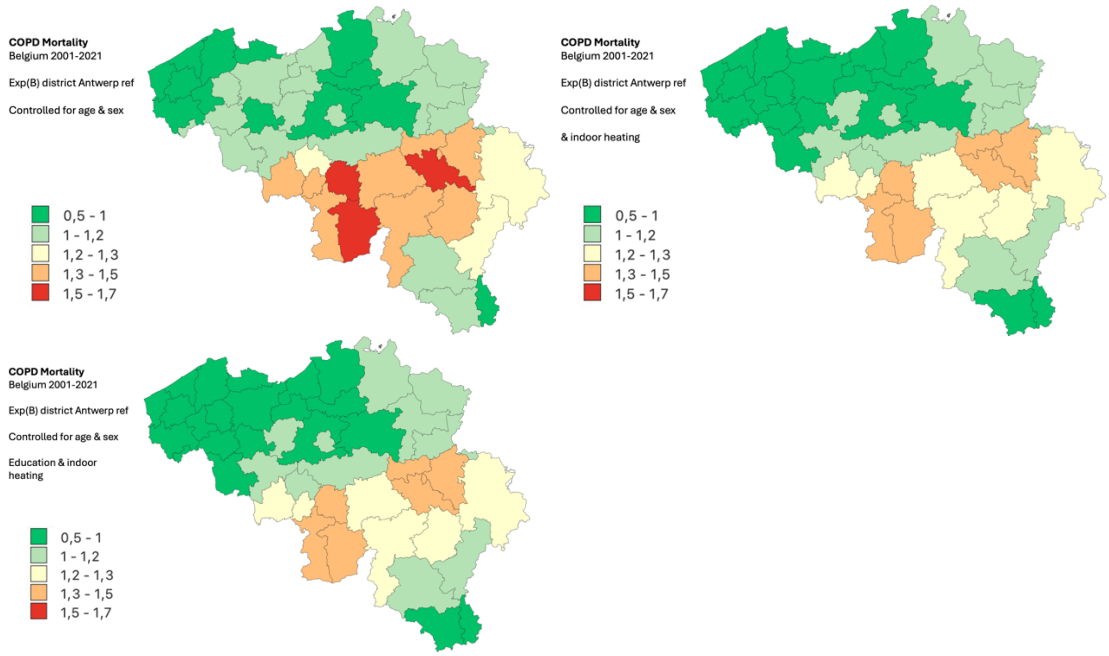
		Exp(B)	95.0% CI		Exp(B)	95.0% CI	
sex	men	2.159	2.138	2.180	2.267	2.242	2.292
	women (ref)						
age		1.115	1.114	1.115	1.114	1.114	1.115
heating	other	**1.306**	1.293	1.320	**1.233**	1.219	1.248
	wood	**1.306**	1.250	1.365	**1.193**	1.135	1.253
	coal	**1.483**	1.460	1.507	**1.353**	1.329	1.378
	central heating (ref)						
education	unknown				1.712	1.657	1.769
	primary				1.660	1.613	1.707
	lower secondary				1.474	1.428	1.520
	lower secondary professional				1.497	1.453	1.542
	higher secondary				1.296	1.253	1.341
	higher secondary technical				1.275	1.229	1.323
	higher secondary professional				1.483	1.427	1.542
	post secondary				1.261	1.176	1.353
	higher education				1.056	1.019	1.093
	university (reference)						

Table 1: Cox regression with days surviving between 2001 and 2021 as time variable. Relative risk for IHD mortality by type of heating controlled for sex and age and for educational attainment.

		Exp(B)	95.0% CI		Exp(B)	95.0% CI	
sex	men	2.664	2.627	2.702	2.763	2.720	2.806
	women (ref)						
age		1.109	1.109	1.110	1.106	1.105	1.107
heating	other	**1.534**	1.512	1.557	**1.360**	1.337	1.382
	wood	**1.541**	1.454	1.634	**1.332**	1.249	1.422
	coal	**1.843**	1.804	1.883	**1.547**	1.509	1.585
	central heating (ref)						
education	unknown				3.131	2.973	3.297
	primary				2.900	2.767	3.040
	lower secondary				2.254	2.143	2.372
	lower secondary professional				2.219	2.113	2.331
	higher secondary				1.789	1.693	1.891
	higher secondary technical				1.595	1.504	1.692
	higher secondary professional				2.190	2.060	2.327
	post secondary				1.743	1.567	1.939
	higher education				1.265	1.194	1.340
	university (reference)						

Table 2: Cox regression with days surviving between 2001 and 2021 as time variable. Relative risk for COPD mortality by type of heating controlled for sex and age and for educational attainment.

Mapping the results on district level we can observe an important impact of heating type on the geographical patterns of cause specific mortality. Education is much less important, suggesting that indoor pollution has a more important impact and acts probably as the direct cause partially determined by socio-economic status or by education as proxy for the latter (fig 3).



Cox regression for COPD mortality in Belgium 2001-2021 with the district of Antwerp as reference category and using fixed intervals to illustrate the shift between categories after control for indoor heating and for educational attainment.
Very few households in Belgium are still using wood or coal burners in 2021. But from this study we can see how noxious this type of heating is for the households in Belgium who remains using this type of heating.

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