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Neighborhoods Effects on Mortality
Poster session 3

A Statistical Analysis to Disentangle the Effect of Neighborhood on Mortality Risks

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The question addressed

Already in 1830 Villermé wrote a report demonstrating that mortality levels were very different between the 12 'arrondissements' of Paris and investigated the causes of such differences by considering several ecological variables observed at neighborhood level (Villermé 1830).

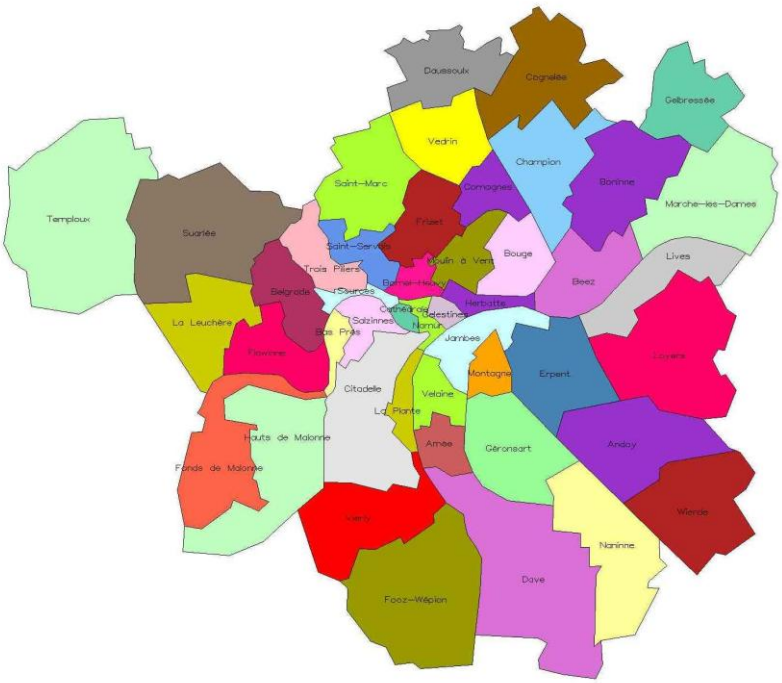
Neighborhood health and mortality inequalities are common in large cities and numerous scientific studies tried to explain these inequalities. In the North America, these inequalities have been recently investigated in the City of Montreal (Ross et al. 2004), New York (Karpati et al. 2006) and more recently in Cincinnati (Maseru et al. 2011).

In this contribution we revisit the impact of the neighborhood environment through ecological variables on individual health status and mortality risks after controlling by individual household and housing variables. Therefore we use the multilevel analysis considering three levels that are the individual, the household/housing and the neighborhood. The data used is related to the population of Namur. 100,000 inhabitants distributed in 46 neighborhoods are characterized at Census 2001 and followed thereafter up to 2006 for survival using the continuous population registration system. The specific characteristics of these neighborhoods can be found at http://cytisenamur.gedap.be/.

Sitting, Data and Methods

The population under study is the one of the city of Namur in Belgium. 100,000 inhabitants are spatially distributed in 46 neighborhoods. (Figure 1).

Figure 1. The city of Namur (Wallonia, Belgium) divided in 46 neighborhoods



Dividing the territory of a large city in neighborhoods must be the result of an approach which is essentially scientific, based on a set of criteria between which a compromise must be found. These neighborhoods are not only a division which aims at a geo-statistical analysis, but also an indispensable key for the development of policy action at the local level. In addition, their spatial definition, as well as their designation, must be subject to a consensus of opinion among the local elected officials, the local administration, and the population. The spatial definition of neighborhoods calls upon a wide range of criteria (Poulain 1999).

For characterizing these 46 neighborhoods we use data extracted from the 2001 census for individual, household, housing and some environment indicators. The continuous population registration system allows following the survival at individual level from the 1st January 2002 up to the 1st January 2006. Both sets of data are linked by using a unique personal identification number.

Beside simple correlations between the outcome variable and various ecological variables observed at neighborhood level, we apply the Cox PH method in order to identify the impact of

the three levels considered on the outcome variable describing the mortality risk alongside the four years of observation. We apply Cox PH to the mortality risk from 2002 to 2006 for 16,651 persons born before 1941 (aged 61 years and over) and living in one of the 46 neighborhoods of Namur in 2002. However we limited our population to those also living in the same neighborhood in 1991 in order to avoid the disturbing impact of migrations occurring between different neighborhoods. Among the population under study, 2,583 (15%) die during the four years period of observation. Due to small population size in some neighborhoods we grouped neighboring neighborhoods in order to work with 39 areas with all of them having more than 100 persons in the analysis.

The explanatory variables used in the analysis are related to the three levels of analysis:

1. At individual level: age (continuous variable = 0 for age 60), sex, marital status (single, married, widowed or other marital status) and level of education (high and low education based on the age at end of scholarship up to 14 or 15 and over).
2. At household level: living arrangement, housing characteristics and an index of satisfaction based on 17 topics (relative value compared to the average of the same satisfaction index for the neighborhood).
3. At neighborhood level: characteristics of the physical environment, aggregated ecological characteristics of the population including population density, proportion of unemployed, average income, social aid per inhabitant… and the absolute value of the index of satisfaction aggregated at neighborhood level.

Results

In the first model we use only the neighborhood as covariate by introducing a multi-categorical variable with 39 different positions. The 'Namur Center' is the neighborhood of reference experiencing the highest gross mortality rate during the period (104 deaths for 444 persons aged 61 years and over in 2002). The standard deviation of the 39 relative mortality risks estimated for each neighborhood is 0.134 and the corresponding coefficient of variation is 22.0%

Thereafter we introduce age and sex as additional covariates (male = reference and age is continuous as calculated starting from 60). The relative mortality risk for female compared to male is 0.519 while every year of age increases the mortality risk by 11.5%. Both covariates are highly significant with $p < 0.001$. The standard deviation is 0,115 and the coefficient of variation has been reduced to 14.2%. We introduce thereafter a first socio-economic variable, the level of education as binary variable (reference = high education) and a multi-categorical variable describing the living arrangement (living alone never married, living alone ever married, living in married couple, other type of private living arrangement and living in collective household with the first group as reference). The standard deviation of the relative mortality risks for each neighborhood is 0.110 and the coefficient of variation is 13.5%.

Afterwards we enter several socio-economic variables extracted from the census 2001 that are related to the household/dwelling level:

- Being owner of your dwelling or not
- Having a car or not for the use of the household
- Having a garden more than 3 are
- Index of comfort of dwelling (high or low level of comfort)

The result of the Cox regression is shown in the table hereunder and the standard deviation for the relative mortality risk in the 39 neighborhoods is 0.135 and the corresponding coefficient of variation is 13.7%

	B	E.S.	Wald	ddl	Signif.	Exp(B)
SEX (ref males)	-,775	,044	312,388	1	,000	,461
AGE (continuous)	,102	,003	1447,431	1	,000	1,107
EDUC (ref high educated)	,183	,042	18,611	1	,000	1,201
LIVING ARRANGEMENT (ref living alone never married			12,280	4	,015	
Living alone ever married	-,004	,054	,007	1	,935	,996
Living in married couple	,079	,115	,470	1	,493	1,082
Living in other private HH	,084	,090	,876	1	,349	1,088
Living in collective HH	,176	,056	9,918	1	,002	1,192
NEIGHBORHOOD			37,915	39	,519	
OWNERSHIP (ref being owner)	,124	,054	5,290	1	,021	1,132
CONFORT (ref high comfort)	,119	,063	3,579	1	,059	1,127
GARDEN (ref having a garden)	,141	,055	6,648	1	,010	1,152
AUTO (ref having access to car)	,189	,062	9,128	1	,003	1,208

Thereafter the final relative mortality risks were correlated with the following set of 20 indicators computed at neighborhood level:

A first group of six indicators describe the housing situation in average in each neighborhood.
A second group of four indicators characterize the average situation in each neighborhood for education level and employment. Two indicators show the level of satisfaction of the persons living in each neighborhood towards their immediate environment and the accessibility to various services and infrastructures as captured in the census 2001. The last indicators are related to social aid, proportion of foreigners, different types of living arrangement and access to car and internet in the household.

Covariates at neighborhood level	Correlation*
Proportion of detached houses	85,2%
Index of quality of housing	84,0%
Average housing renting cost	82,8%
Proportion of housing occupied by their owner	78,8%
Average number of rooms per dwelling	77,6%
Proportion of those having a large garden of more than 3 are	
Proportion of persons aged 25 years and over with low education	76,7%
Proportion of unemployed persons looking for a job	
Ratio between blue and white collar workers	76,7%
Ratio between persons employed in public and private companies	72,1%
Global index of satisfaction for the environment	71,5%
Global index of satisfaction for services and infrastructures	62,0%
Average social aid distributed per inhabitant	60.4%
Proportion of foreigners	54.5%
Annual immigration from outside Namur (per thousand inhabitants)	
Proportion of persons living alone	
Proportion of persons living in 'classical' household composed by a married couple with ou without children	
Proportion of women aged 30 years and more that are not married and never cohabitated	
Proportion of persons in a household with access to at least one car	
Proportion of persons having access to internet at home	

- Preliminary results

Further investigations

Several possibilities for additional investigations exist:

1. We intend to oppose those persons who stay in the same neighborhood from 1991 to 2001 and those who move between neighborhoods within this period and to compare their survival after up to 2006.
2. We can also oppose stayers in 'bad' or in 'good' neighborhood with movers from 'bad' to 'bad', from 'good' to 'good', from 'bad' to 'good' and from 'good' to 'bad'. We may also consider separately those who arrived in a 'good' or 'bad' neighborhood during the period and those who left.
3. By comparing if individual characteristics are similar to the ones of their neighborhood or opposed we may select and compare the relative mortality risk of 'good' people living in 'bad' neighborhood and 'bad' people in 'good' neighborhood with the one of 'good' people in 'good' neighborhood and 'bad' people in 'bad' neighborhood.
4. We intend to consider not only the mortality risk but also the health status based on the self rated health status extracted from the census 2001.

Policy implications

The examination of the variation of demographic and socio-economic structures within the cities themselves quite often displays the existence of quite varied structures. It is not unusual to discover that the proportions of the elderly, young people or people living alone can double or triple from one neighborhood to another. It can also happen that certain spatially contiguous neighborhoods display structures and population's behavior that are quite opposed. Hence, for the majority of cities, we are forced to note that the demographic and socio-economic picture is not homogenous at the internal level and as a result of that, local management needs must act in full knowledge of these disparities.

By evidence the health status and mortality risk depend on individual characteristics but they are also related to living arrangement within the household and living conditions linked to housing characteristics. The effect of individual variables give little place for policy implications while the housing variables are more appropriate for developing action plans that could indirectly improve the health status and reduce the mortality risks of the occupants.

What remains at the neighborhood level as a possible impact for reducing mortality risks? The results of the statistical analysis help identifying the key variables at neighborhood level. Satisfaction indices, employment variables and concentration of persons showing individual higher mortality risks emerge from preliminary results showing the direction to follow for an effective policy support to reduce health and mortality disparities between neighborhoods in the city. Nevertheless our preliminary investigation shows that neighborhood variables have a limited impact to explain differences in the relative mortality risk of each neighborhood.

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