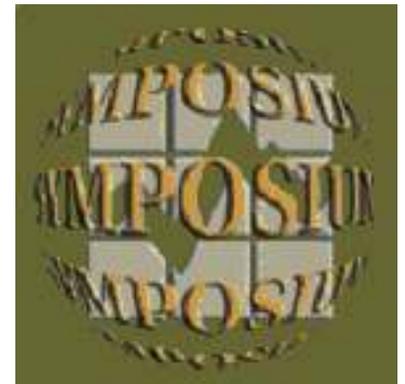


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## Immigrant Populations and Myocardial Infarctions

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### Abstract

Immigrants have health advantages over native-born Canadians, but those advantages are threatened by specific risk situations. This study explores cardiovascular health outcomes in districts of Montréal classified by the proportion of immigrants in the population, using a principal component analysis. The first three components are immigration, degree of socio-economic disadvantage and degree of economic disadvantage. The incidence of myocardial infarction is lower in districts with large immigrant populations than in districts dominated by native-born Canadians. Mortality rates are associated with the degree of socio-economic disadvantage, while revascularization is associated with the proportion of seniors in the population.

KEYWORDS: Myocardial infarction, immigrants, districts, Montréal, incidence, revascularization, mortality

### 1. Introduction

Age, sex, family background, lifestyle and ethnic origin are the leading risk factors for cardiovascular disease (Heart and Stroke Foundation of Canada, 2003). However, the importance of other factors is becoming clear over time. It is now recognized that myocardial ischemia can be precipitated by mental stress resulting from emotional states such as anxiety or anger, and that the effects of that stress are influenced by such things as the support network available to the individual (Jiang *et al.*, 1996; Jain *et al.*, 1998). It has also been established that socio-economic status is associated with the prevalence and risk of chronic illness and cardiovascular disease (Johansen *et al.*, 1998; Smith *et al.*, 1998; Dalstra *et al.*, 2005). In addition to those individual factors, there are the conditions of the district of residence, which, independently of the individual characteristics, influence the risk of suffering a myocardial infarction, the mortality rate before reaching hospital, the hospitalization rate and long-term survival (Morrison *et al.*, 1997; Leclere *et al.*, 1998; Smith *et al.*, 1998; Bosma *et al.*, 2001; Diez Roux *et al.*, 2001; Huo et Chen, 2003; Feldman *et al.*, 2004; Sundquist *et al.*, 2004; Tonne *et al.*, 2005). For example, individuals who live in low-income districts generally have a high risk of suffering a myocardial infarction and dying before reaching hospital, as their long-term survival is lower than that of individuals living in higher-income districts. Among the factors that may account for those differences are the high prevalence of other diseases, poorer general health, poor perception of the symptoms, social isolation, occupational stress, depression, exposure to contaminants, inadequate housing, and limited availability of resources and services to promote or maintain healthy lifestyles (Morrison *et al.*, 1997; Leclere *et al.*, 1998; Diez Roux *et al.*, 2001; Sundquist *et al.*, 2004). Those factors interact and determine “risk situations” for health and cardiovascular disease (Heart and Stroke Foundation of Canada, 2003).

Immigrants' health and its determinants are research topics of interest in Canada because more than 200,000 immigrants settle here each year, and immigrants make up about 18% of the country's population (Hyman, 2001; Schellenberg, 2004). The majority of studies show that recent immigrants, particularly those from non-European countries, are better-off than immigrants who have been in Canada for many years and native-born Canadians in terms of general health and the prevalence of certain chronic illnesses, such as cancer and heart disease. Hence they support the “healthy immigrant effect” hypothesis, which has been corroborated in other countries, such as the United States and Australia (Chen *et al.*, 1996; Kinnon, 1999; Ali *et al.*, 2004; Hyman, 2001, 2004; McDonald and Kennedy, 2004; Ng *et al.*, 2005). That effect may be attributable to two processes: (a) self-selection of individuals who want to emigrate and are able to emigrate, which screens out unhealthy individuals, and (b) selection of the “best” immigrants based on education, knowledge of the language and occupational skills, characteristics that

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facilitate social and economic integration, and are associated with a healthy lifestyle (Hyman, 2001). Those immigration processes would apply to economic immigrants, who make up 60% of all immigrants, and not to protected persons or people who immigrate under the family reunification program (Citizenship and Immigration Canada, 2005).

Among the various determinants of health, factors such as income, education, social support and discrimination seem to be more important for immigrants than for non-immigrants (Dunn and Dyck, 2000; Laroche, 2000; Hyman, 2001). Inadequate recognition of educational credentials and work experience acquired abroad, and loss of socio-economic status contribute to stress and poor mental health, which in turn affect physical health, contributing to a decline in immigrants' health over time (Newbold, 2005). Available information also indicates that pre-immigration and post-immigration experiences that are unique to immigrants are factors in their health, at least in the short term (Kinnon, 1999).

Thus, the literature suggests that the health advantages enjoyed by immigrants, especially recent immigrants, are jeopardized by risk situations that are unique to them. At present, nothing is known about the cardiovascular health of those subpopulations at the level of Canadian cities. This study examines whether certain cardiovascular health outcomes vary from district to district in a large city such as Montréal depending on the proportion of the immigrant population. Specifically, the study's objectives are as follows:

1. Classify the districts of the Montréal census metropolitan area by the population's socio-economic and immigration characteristics.
2. Describe and compare the incidence of myocardial infarction, revascularization treatment and post-myocardial infarction survival based on the districts' socio-economic and immigration characteristics.

## 2. Methodology

This is an ecological study of the 25-and-over population of the Montréal census metropolitan area (CMA) in 2001. The unit of analysis is the census tract (CT), which corresponds to a district. The 846 CTs, for which 2001 Census of Population data are available for the population variables, were included in the study (Statistics Canada, 2001). Attribute data on health outcomes are from the Ministère de la Santé et des Services Sociaux du Québec (MSSS) and the MED-ÉCHO information system, a database intended for studies of hospital patients. The spatial data are from the 2001 Census of Population CT boundary file (Statistics Canada, 2001). The study was divided into several steps, as described below.

### 2.1 Classifying the census tracts

The objective of this first step is to classify the CTs by population characteristics. Because the available variables are so diverse, a principal component analysis (PCA) was performed to identify the main variation axes for the CTs and the key variables associated with them. Of the models examined, the one selected was the factorial PCA with a 17-variable varimax rotation (SAS Factor procedure). Some of the variables were normalized (logarithmic or quadratic transformations) to make the PCA's results clearer. Then, for each of the first three principal components or axes, the CTs were ranked by factorial score and assigned to five levels or classes by population quintile.

### 2.2 Calculating the health outcomes

For the three axes, the health outcomes were calculated for each CT class as described below.

#### 2.2.1. Incidence of myocardial infarction (MI)

The numerator is the number of patients aged 25 and over admitted to hospital with a principal diagnosis of MI (ICD-9 code 410) between January 1 and December 31, 2001, whose home postal code belongs to a CT in the class of interest. The denominator is the population aged 25 and over of the CTs in the class of interest. The numerator data are from the MED-ÉCHO system, and the denominator data are from the 2001 Census of Population.

#### 2.2.2. Rate of revascularization at index hospitalization

The numerator is the number of patients whose home postal code belongs to a CT in the class of interest who underwent revascularization (angioplasty or coronary artery bypass, Canadian procedure codes 480 to 483) during the index hospitalization. The denominator is the number of patients aged 25 and over admitted to hospital with a principal diagnosis of MI between January 1 and December 31, 2001, whose home postal code belongs to a CT in the class of interest (numerator of the incidence of MI – see 2.2.1). The data are from MED-ÉCHO.

### **2.2.3. Death rate from all causes at 12 months**

The numerator is the number of patients whose home postal code belongs to a CT in the class of interest who died up to 12 months after their date of admission to hospital for MI. The denominator is the number of patients aged 25 and over admitted to hospital with a principal diagnosis of MI between January 1 and December 31, 2001, whose home postal code belongs to a CT in the class of interest (numerator of the incidence of MI). The numerator data are from the MSSS death register.

### **2.2.4. Specific death rate due to cardiovascular disease (CVD) at 12 months**

The numerator is the number of patients whose home postal code belongs to a CT in the class of interest who died of CVD (ICD-9 codes 410 to 414 and 426 to 429) up to 12 months after their date of admission to hospital for MI. The denominator is the number of patients aged 25 and over admitted to hospital with a principal diagnosis of MI between January 1 and December 31, 2001, whose home postal code belongs to a CT in the class of interest (numerator of the incidence of MI). The numerator data are from the MSSS death register.

## **2.3 Comparison of CT classes based on health outcomes**

For each of the four health outcomes, the CT classes were compared using Fisher's exact test and the chi-square test.

## **2.4 Identification of the population features associated with health outcomes**

To identify the population features that are represented by the first three principal components and are associated with health issues, Poisson regression models were developed using the SAS Genmod procedure. The dependent variables are the health outcomes of interest, and the independent variables are the quintiles corresponding to the three main axes. The models were adjusted for the proportion of the CT's population that were 65 and over.

## **3. Results and Discussion**

The first three principal components have an eigenvalue greater than 1 and account for 82% of data variability (Table 1). The immigration variables are associated with the first principal component, which is interpreted as an axis representing the magnitude of immigration in the population. The variables that describe features such as the proportion of persons living alone and single-parent families, the employment rate and the proportion of renters are associated with the second principal component, which is interpreted as an axis that represents the population's degree of socio-economic disadvantage. Finally, variables such as income and education are associated with the third principal component, which is interpreted as an axis that represents the population's degree of economic disadvantage. The last two principal components explain a similar proportion of the data variability, less than the first component. At the CT level, then, immigration appears to be the largest source of variation in the population. The other two principal components are conceptually close to the material and social aspect of the disadvantage index developed by Pampalon *et al.* (2004).

The CTs that have significant numbers of immigrants are on the island of Montréal, whereas the CTs in which native-born Canadians predominate are on the north and south shores (Figure 1a). This concentration of immigrants in certain districts, particularly in the central parts of large Canadian cities, is described in the literature (Schellenberg, 2004). The settlement of immigrants in the downtown areas is probably associated with the many social institutions that assist immigrants there, and with the lower cost of shelter (Hiebert, 2000). However, a growing tendency for immigrants to settle in the suburbs has been observed in Toronto and Vancouver (Hiebert, 2000).

**Table 1. The first three principal components (axes) and the associated variables**

	“Immigration” axis	“Socio-economic disadvantage” axis	“Economic disadvantage” axis
Percentage of the variance explained by the axis	39.08%	22.55%	20.21%
Variable			
Proportion of immigrants*	0.98	0.19	-0.02
Proportion of immigrants who arrived between 1981 and 1990*	0.91	0.14	0.04
between 1971 and 1980*	0.89	0.00	-0.05
between 1991 and 1995*	0.88	0.26	0.06
between 1961 and 1970*	0.83	-0.09	-0.10
between 1996 and 2001*	0.79	0.43	-0.03
before 1961*	0.73	0.04	-0.07
Proportion of the population that does not speak an official language*	0.87	0.12	0.26
Proportion of persons aged 15 and over living alone	0.12	0.93	-0.10
Proportion of renters	0.36	0.84	0.26
Proportion of persons aged 15 and over who are separated, divorced or widowed*	-0.21	0.78	0.29
Employment rate	-0.37	-0.64	-0.45
Proportion of lone-parent families	0.16	0.62	0.52
Proportion of persons aged 20 and over who did not graduate from secondary school	-0.04	0.19	0.94
Proportion of persons aged 20 and over who have some university education	0.37	0.15	-0.88
Median family income**	-0.25	-0.51	-0.72
Median income of persons aged 15 and over**	-0.38	-0.46	-0.72

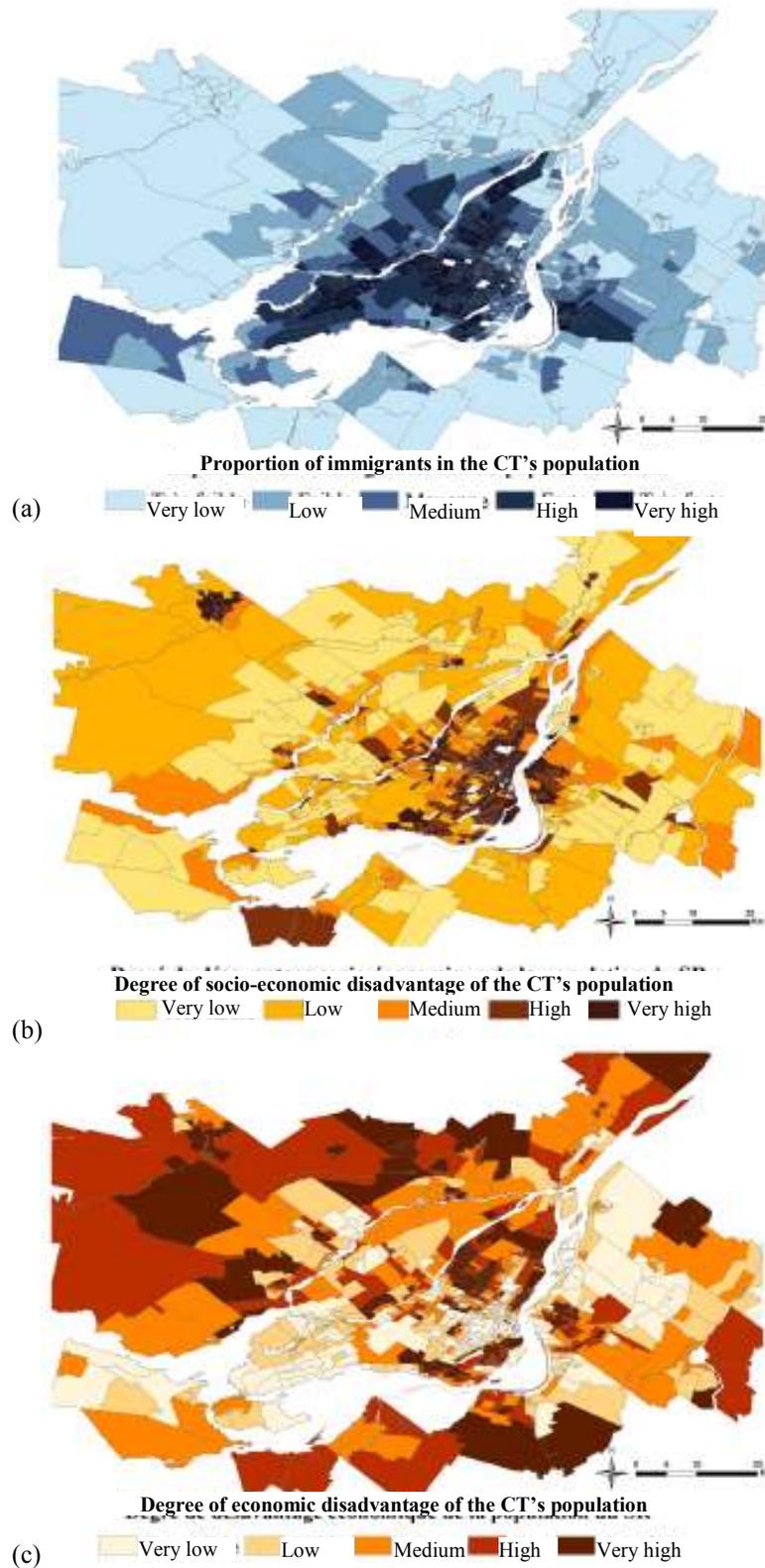
\* Quadratic transformation    \*\* Logarithmic transformation

Note: The figures represent the coefficient of correlation between the variable and the principal component.

CTs that are highly disadvantaged socially or economically are located not only on the island of Montréal, but also on the north and south shores (Figure 1b and c). Analysis of the three maps indicates that districts with a large proportion of immigrants are not necessarily the most disadvantaged. This finding is consistent with studies that show that the relationship between immigration and poverty is weaker in Montréal than in Toronto and Vancouver, since the highest concentration of poverty is in districts with a low proportion of immigrants (Kazemipur and Halli, 1997; Ley and Smith, 1997).

When we compare the CTs located at the ends of the axes, i.e., in the first and fifth population quintiles, the incidence of MI is the only outcome with which immigration has a significant correlation (Table 2). The incidence of MI is significantly lower in CTs with a large immigrant component than in CTs dominated by native-born Canadians. For the other axes, the population quintiles that are most disadvantaged socially or economically show a significantly higher incidence of MI than the more affluent quintiles. The patterns are similar for the other health outcomes (Table 2). The revascularization rate is significantly higher in the socially and economically more affluent CTs. In contrast, the mortality rates for all causes and from cardiovascular disease are significantly lower in socio-economically more affluent CTs than in highly disadvantaged CTs. Only the socio-economic disadvantage axes shows significant differences for the four health outcomes. Poisson regression models confirm these results, and they provide another perspective on the matter. When the incidence of MI in CTs is modeled for the quintiles of each axis and adjusted for the proportion of the population aged 65 and over, we find that the variables that have a significant effect on the incidence of MI are the proportion of the elderly population, the degree of economic disadvantage and immigration (Table 3). For the revascularization rate, the only variable that has a significant effect is the proportion of the elderly population. For the mortality rates, the degree of socio-economic disadvantage has a greater effect than the proportion of the elderly population. Hence, the incidence of MI seems to depend on the population’s age, the economic conditions and immigration, in that order, while mortality depends mostly on socio-economic conditions.

# MONTRÉAL CMA



**Figure 1. Spatial distribution of CTs assigned to population quintiles on the basis of their factorial score for three axes: (a) immigration, (b) socio-economic disadvantage, and (c) economic disadvantage**

**Table 2. Health outcomes of the first and fifth population quintiles for each of the three axes**

CT class	Population aged 25 and over	Incidence of MI per 100,000	Revascularization rate(%)	Death rate at 12 months, all causes (%)	CVD death rate at 12 months (%)
“Immigration” axis					
Quintile 1: Very low	457,875	262.3 *	35.7	18.6	11.2
Quintile 5: Very high	467,525	212.8	34.1	21.3	13.8
“Socio-economic disadvantage” axis					
Quintile 1: Very low	436,390	182.8 *	41.6 *	13.2 *	7.8 *
Quintile 5: Very high	508,400	276.1	32.7	24.8	16.1
“Economic disadvantage” axis					
Quintile 1: Very low	479,060	182.0 *	40.2 *	19.5	13.3
Quintile 5: Very high	462,375	269.2	34.5	19.9	13.4

\* p &lt; 0.05

**Table 3. Poisson regression model of the health outcomes by CT quintile for each of the three axes and by the proportion of the population aged 65 and over in the CT. Quintile 5 of each axis is used as the reference point ( $\beta=0$ ).**

		Incidence of MI	Revascularization rate	Death rate at 12 months, all causes	CVD death rate at 12 months
“Immigration” axis quintile					
Quintile 1: Very low	B	0.28	-0.0001	-0.13	-0.20
	$\chi^2$	40.78	0.00	1.73	2.62
	p-value	< 0.0001	0.99	0.18	0.11
“Socio-economic disadvantage” axis quintile					
Quintile 1: Very low	B	-0.01	0.07	-0.48	-0.56
	$\chi^2$	0.04	0.71	14.20	12.10
	p-value	0.83	0.40	0.0002	0.0005
“Economic disadvantage” axis quintile					
Quintile 1: Very low	B	-0.40	0.16	-0.08	-0.06
	$\chi^2$	79.41	4.44	0.65	0.27
	p-value	< 0.0001	0.035	0.42	0.61
Population 65 and over					
	B	3.15	-1.46	1.38	1.26
	$\chi^2$	272.17	16.21	12.36	6.63
	p-value	< 0.0001	< 0.0001	0.0004	0.01

Our results show a lower incidence of MI in populations with a large immigrant component, which is consistent with the “healthy immigrant” hypothesis, the effect of which has been observed in Canadian studies (Chen *et al.*, 1996; Kinnon, 1999; Hyman, 2001, 2004; Ali *et al.*, 2004; McDonald and Kennedy, 2004; Ng *et al.*, 2005). On the other hand, similar mortality rates were found for immigrants and native-born Canadians, which contradicts the hypothesis. It is possible that differences in mortality rates are attenuated by the high level of heterogeneity among immigrants with respect to ethnic origin, length of time in Canada and immigration status. The literature indicates that first, the healthy immigrant effect fades over time, and second, heart disease mortality rates vary by ethnicity, as Scandinavians and Africans have the highest rates while Asians and Latin Americans have the lowest rates (Hyman, 2001). Research by Sheth *et al.* (1999) also shows that for men, ischemic heart disease mortality is higher among South Asians and native-born Canadians, and significantly lower among males of Chinese origin. For women, mortality is higher among South Asians than among Canadians and Chinese immigrants (Sheth *et al.*, 1999). With respect to health care, the fact that the revascularization rate is correlated solely with the proportion of elderly people in the CT may be due to the Quebec health system’s universal access characteristics. In Montréal, accessibility depends more on social and cultural features than on geographic or economic features. This may also explain, at least in part, the fact that mortality rates are associated with the degree of socio-economic disadvantage and not with the degree of economic disadvantage. Another very interesting point is that the employment rate, which is associated with the socio-economic axis, has a very high social connotation (Zunzunegui *et al.*, 2006). We can conclude that in Montréal, on the economic front, the employment rate is more highly correlated with health than income is, though

the relationship between cardiovascular health and socio-economic status is well documented in Quebec and various countries (Diez Roux *et al.*, 2001; Burnley and Rintoul, 2002; Martinez *et al.*, 2003; Sundquist *et al.*, 2004; Tonne *et al.*, 2005).

#### 4. Conclusions

Principal component analysis is a useful technique for classifying CTs by groups of related variables rather than by just one variable. For example, the technique shows that in the Montréal census metropolitan area, the main source of variation between CTs is immigration, while the population's economic and social conditions play a less important role as sources of variation. However, the three aspects – immigration, the economic aspect and the social aspect – do not necessarily overlap in space; that is, districts with a high proportion of immigrants are not necessarily the most disadvantaged districts from a social and economic standpoint. Populations with a large immigrant component and populations consisting mostly of native-born Canadians differ solely in the incidence of myocardial infarction, which is lower among immigrants. Differences in mortality rates are associated with the degree of socio-economic disadvantage, which according to our definition includes the employment rate. Differences in health care are associated with the proportion of elderly people in the population.

This study is the first step in exploring the relationship between the immigrant component of populations and cardiovascular health outcomes in Montréal. Since immigrants are very heterogeneous with respect to their status and social and economic conditions, the next step is to compare immigrant populations and native-born Canadian populations that live in similar socio-economic conditions.

The poor quality of the variable that indicates patients' country of birth in the MED-ÉCHO register limits its usefulness for studies at the individual level.

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