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Myocardial infarction in Québec rural and urban populations between 1995 and 1997

Introduction: There is abundant evidence of health inequities between urban and rural populations. The purpose of this paper is to describe the socioeconomic characteristics of Québec urban and rural populations and the relation between rurality and incidence of myocardial infarction (MI), care management and outcomes.

Methods: Socioeconomic data by census subdivisions were available from the 1996 Canadian census, representing 7 137 245 individuals. Data on patients with MI were taken from the provincial administrative health database (MED-ECHO), which is managed by the Ministry of Health and contains clinical and demographic information collected when patients are released from acute care hospitals in Québec.

Results: We included a total of 37 678 cases compiled over the 3 years of follow-up in the analyses. Residents of rural areas with low urban influence have higher MI incidence rates than all of the other populations in the study. In comparison with urban populations, their observed rural counterparts are at a disadvantage with regard to education, employment and income. Although angioplasty and coronary artery bypass graft surgery rates were higher in more urban areas, the survival rate was lower than in rural areas.

Conclusion: This study revealed geographic heterogeneity of MI incidence, revascularization rates and survival rates among urban and rural populations.

Introduction : Il existe d'abondantes preuves d'inégalités sur le plan de la santé entre les populations urbaines et rurales. Cette communication vise à décrire les caractéristiques socioéconomiques de populations urbaines et rurales du Québec et le lien entre la ruralité et l'incidence de l'infarctus du myocarde (IM), la prise en charge des soins et les résultats.

Méthodes : Des données socioéconomiques par subdivision de recensement étaient disponibles, tirées du Recensement canadien de 1996 et représentant 7 137 245 personnes. Les données sur les patients victimes d'un IM proviennent de la base de données administratives sur la santé de la province (MED-ECHO), gérée par le ministère de la Santé et qui contient des renseignements cliniques et démographiques recueillis lorsque les patients ont obtenu leur congé d'hôpitaux de soins actifs au Québec.

Résultats : Nous avons inclus au total 37 678 cas compilés au cours des trois années de suivi prévues dans les analyses. Les résidents de régions rurales où l'influence urbaine est faible présentent des taux plus élevés d'incidence d'IM que toutes les autres populations visées par l'étude. Comparativement aux populations urbaines, leurs homologues ruraux observés sont désavantagés sur les plans de l'éducation, de l'emploi et du revenu. Même si les taux d'angioplasties et de pontages aortocoronariens étaient plus élevés dans plus de régions urbaines, le taux de survie y était plus faible que dans les régions rurales.

Conclusion : Cette étude a révélé une hétérogénéité géographique de l'incidence de l'IM, des taux de revascularisation et des taux de survie dans les populations urbaines et rurales.

INTRODUCTION

When it comes to the planning and delivery of health-care services, rural populations present governments with unique challenges. It is these geographic, environmental and socioeconomic challenges of the rural world that Canada and other countries have begun to address with renewed vigour.[1–3] The Québec government is particularly preoccupied with rurality since its so-called geographic rural area is one of the largest in the world and contains more than 1.6 million people—about 20% of the Québec population.[2]

There is abundant evidence of health inequities between urban and rural populations.[4,5] Various factors may account for these geographic disparities. It has been shown that rural populations are socio-economically disadvantaged [6–8] and it has been proven that socioeconomic status has an impact on health.[9,10] Accessibility to health care and services, which is a constant concern for rural populations, must also be considered when examining these health disparities.[11,12]

Similar inequities are found in the incidence, care management and clinical outcomes of cardiovascular disease (CVD).[13–16] Inequities in major risk factors for myocardial infarction (MI) were also noticed.[17] CVD accounts for more than one-third of deaths and is the leading cause of morbidity and mortality in Canada. CVD also represents a huge economic burden, totaling $20 billion annually, according to Health Canada.[18] In addition, with the burgeoning aging population, the number of annual deaths associated with CVD is expected to double by the year 2018.[13]

These observations raise a wide range of questions and there is an increasing amount of scientific research on the health of rural populations.[19,20] The study of MIs in relation to the concept of rurality could contribute to the development of knowledge and help improve prevention, health promotion and planning programs in this field.

Definition of the concept of rurality

Despite its growing interest, there is no universally accepted definition of rurality, which makes it difficult to compare results from research on the subject.[21] Articles on rurality often use implicit definitions of this concept without specifying the details or the origin of these definitions.[22] In Canada, there is no consensus on the operational definition of rurality. At the governmental level, Statistics Canada and the Rural Secretariat use 6 different definitions to distinguish rural from urban areas.[23] The majority of these definitions use census tract as the unit of analysis, and population size and density as criteria for categorization. Depending on the definition used, the size and composition of the Canadian rural population varies from 22% to 38%.[24]

The Statistical Area Classification (SAC) provides one of many definitions of rurality employed by Statistics Canada.[25] It is the only definition that includes a functional criterion, namely, the commuter ratio. This ratio represents the percentage of a municipality's residents who travel to work daily to an urban area. According to the SAC definition, there are 2 categories of urban areas, depending on the size of the urban core population: Census Metropolitan Areas, with populations of at least 100 000 people, and Census Agglomerations, with populations between 10 000 and 99 999 people.[26] Rural areas include all Census Subdivisions or municipalities not counted in urban areas, which totaled about 80% of Census Subdivisions in 1996. These Census Subdivisions fall into 1 of 4 categories of rurality depending on the influence of urban centres. The 4 categories, or Metropolitan Influenced Zones, are also defined by the commuter ratio (Table 1).[27] Details about the SAC and the criteria employed for its development can be found on the Statistics Canada Web site.[28]

Research objectives

The study objectives were, first, to describe the socioeconomic profile of Québec urban and rural populations according to the SAC; and, second, to describe the relation between rurality in Québec and MI incidence, post-MI revascularization rates and post-MI survival rates at 1, 3, 6, 9 and 12 months.

METHODS

Study population

For the first objective, socioeconomic data by Cen-

Table 1. Categories of Metropolitan Influenced Zones

Statistical Area Classification	Commuter ratio*
Metropolitan Influenced Zones	
Strong	>30%
Moderate	5%–30%
Low	0%–5%
Absent	<40 Census Subdivision residents

*The commuter ratio of a Census Subdivision is the percentage of its residents who commute to work in any Census Metropolitan Area or any Census Agglomeration.

sus Subdivisions were available from the 1996 Canadian census (i.e., a total of 7 137 245 individuals representing 93.6% of the Census Subdivisions). The Census Subdivisions for which data were unavailable were isolated and often uninhabited.

For the myocardial incidence analysis, we included all Québec residents aged 25 years and older, as identified by the 1996 Canadian census. For the revascularization and survival rates, the cohort consisted of all patients admitted to a Québec hospital with the main diagnosis of MI (code 410 of the International Classification of Diseases, 9th Revision) between January 1, 1995 and December 31, 1997. The first hospitalization during this period was considered the index hospitalization and each patient could only be counted once in the cohort. We excluded anyone who had been hospitalized during the year prior to the index event to include only new MI cases or stable CVD cases. Finally, for the revascularization rates, we excluded deaths in the first 12 months of follow-up to have a common denominator for all the measures.

Other authors performed validation studies on the use of code 410 in identifying MI cases as the main diagnosis,[29,30] including one study from the province of Québec (6 hospitals in the Montréal area) that found a positive predictive value of 95% (95% confidence interval 0.93–0.98) for the MI coding.[31]

Variables

The data used to categorize each Census Subdivision according to its level of rurality were taken from Statistics Canada databases. We first attributed one of the 6 SAC codes to each Census Subdivision in Québec using a digital file.[32] The Census Subdivision Cartography Boundary Files[33] were then used to map the different SACs in the province using ArcGIS software (Release 9.2, ESRI, Redland, Calif.). Fig. 1 is a map of Québec subdivided into the 6 levels of urbanity and rurality as established by the SAC. We used the socioeconomic data (sex, age, marital status, income, employment rate and education) from the cumulative profiles tables by Census Subdivision in the 1996 census.

We used the data on patients with acute MI from the provincial administrative health database (MED-ECHO), which is managed by the Ministry of Health and contains clinical and demographic information collected upon patients' release from acute care hospitals in Québec.[34] We identified revascularization procedures using the codes in the Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures

(CCP).[35] We used the codes that identified percutaneous transluminal coronary angioplasty (PTCA) (beginning with CCP code 480) or coronary artery bypass graft (CABG) surgery (beginning with CCP codes 481, 482 or 483). We examined revascularization rates for the index hospitalization, and at 1, 3, 6, 9 and 12 months to see if they changed over time. Finally, the "Statistiques démographiques" (demographic statistics) database was the data source for post-infarction deaths.[36] We also studied survival rates using time intervals during a 12-month period. We classified MI patients into the corresponding level of rurality using the postal codes of their residences.

Data analysis

The measure of association between the studied variables was based on a comparison of the frequency of the observed phenomena (dependent variables) among the 6 SAC categories. We performed the following statistical tests to detect any significant differences between the observed results: analyses of variance and t tests for the continuous variables, and chi-square tests for the categorical variables. The analyses concerning MI were adjusted for age and sex using the "direct" method.[37] All the analyses were performed with StatXact-5 (CYTEL Software Corp., 2001, Cambridge, Mass.), SAS (Release 8.02, SAS Institute Inc., 1999, Cary, NC) and SPSS (Release 11.0.1, SPSS Inc., Chicago, Ill.).

Ethical considerations
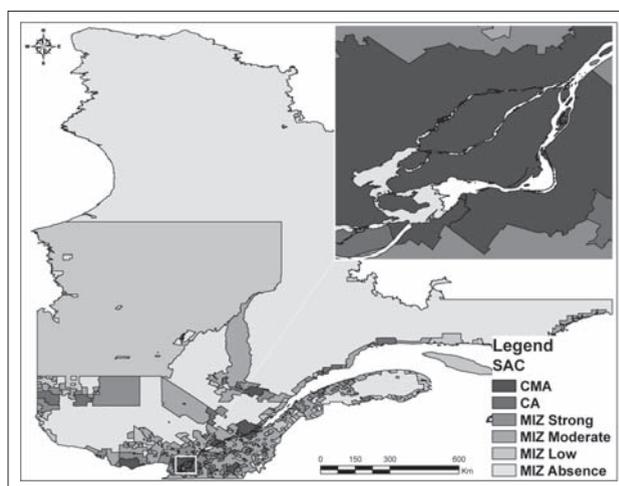
This project was approved by the Sherbrooke Uni-

Fig. 1. Map of the province of Québec subdivided into the 6 levels of urbanity and rurality, — the Census Metropolitan Area (CMA) the Census Agglomeration (CA) and the 4 Metropolitan Influenced Zones (MIZs) — established by the Statistical Area Classification (SAC).

versity Hospital Ethics Board and the Commission d'accès à l'information du Québec.

RESULTS

Table 2 presents the urban and rural categories with socioeconomic characteristics of the studied cohort of 7 137 245 people. There is a higher percentage of women in the urban areas (Census Metropolitan Areas and Census Agglomerations). Even if there is a statistically significant difference between groups regarding age, no particular trend is observed between urban and rural areas, with the exception of areas without metropolitan influence, for which the average age is much lower. Regarding marital status, urban populations include a higher percentage of people who live alone, whereas there is a higher proportion of married people within the rural population. The level of education declines progressively in rural areas, as do the employment rate and average income.

We calculated the MI incidence rates for members of the population aged 25 years or older (n = 4 817 170). We included a total of 37 678 cases compiled over the 3 years of follow-up in the analyses (Table 3). MI rates in the large Census Metropolitan Area are significantly lower than those in the small urban centres (Census Agglomerations) and rural areas. Residents of rural areas with low urban influence have higher MI incidence rates than all the other populations in the study.

On a short-term basis, the PTCA rate was significantly higher in urban areas but patients living in rural areas without metropolitan influence pre-

sented the highest rates at 6, 9 and 12 months (Fig. 2). The PTCA rate for individuals in small urban centres (Census Agglomerations) was also lower than in some rural areas. The CABG surgery rate was higher in urban areas and in rural areas with strong or moderate urban influence, compared with rural areas with low or no metropolitan influence (Fig. 3).

Analysis of post-MI survival rates shows that in the year following an MI, individuals in urban areas had a higher mortality rate than those in rural areas with a moderate metropolitan influence (Metropolitan Influenced Zone, moderate) (Fig. 4).

DISCUSSION

This study aimed to describe the socioeconomic characteristics of Québec urban and rural populations and to describe the relation between rurality and incidence of MI, care management and outcomes.

Table 3. Age- and sex-adjusted incidence rates of myocardial infarction over a 3-year period (n = 37 678)

Statistical Area Classification	Population	Incidence rate* (per 1000 people)
CMA	3 188 930	7.21
CA	570 725	8.34
MIZ		
Strong	280 100	7.68
Moderate	539 585	8.10
Low	205 090	9.26
Absent	32 740	7.47

CMA = Census Metropolitan Area; CA = Census Agglomeration; MIZ = Metropolitan Influenced Zone.
*The difference is statistically significant ($p < 0.05$).

Table 2. Number of Census Subdivisions and population characteristics by Statistical Area Classification (n = 7 137 245)

Statistical Area Classification	Census Subdivisions, n	Population	Sex,* % female	Mean age* (SD)	Live alone,* %	Less than ninth grade education,* %	Mean income,* $CDN (SD)	Unemployed,* %
CMA	199	4 693 125	51.6	36.8 (21.4)	57.2	15.5	24 474 (5275)	11.3
CA	108	849 800	51.3	37.3 (21.7)	56.9	19.6	21 974 (2529)	12.0
MIZ								
Strong	272	422 895	48.9	36.0 (21.4)	51.8	21.8	21 039 (2958)	12.7
Moderate	587	801 445	49.8	37.9 (22.3)	52.4	26.1	19 287 (2549)	13.9
Low	190	315 650	49.7	36.1 (21.7)	53.7	26.2	20 599 (4073)	17.2
Absent	111	54 330	48.7	33.9 (21.8)	54.5	31.4	19 369 (4016)	21.2

SD = standard deviation; CMA = Census Metropolitan Area; CA = Census Agglomeration; MIZ = Metropolitan Influenced Zone.
*The difference between urban and rural areas is statistically significant ($p < 0.05$).

Population characteristics

The mean age and sex distribution of our study population differs slightly across the 6 rural–urban categories. Analysis of the other socioeconomic variables shows 2 major trends. First, a higher percentage of individuals in rural areas are married whereas individuals in urban centres are more likely to live alone. Second, as rurality levels increase, education, job rates and average income decline, which is consistent with results from previous studies.[7] Rural areas without metropolitan influence (Metropolitan Influenced Zone, absent) appear to be demographically different from other rural areas. The Census Subdivisions in rural areas without metropolitan influence (Metropolitan Influ-
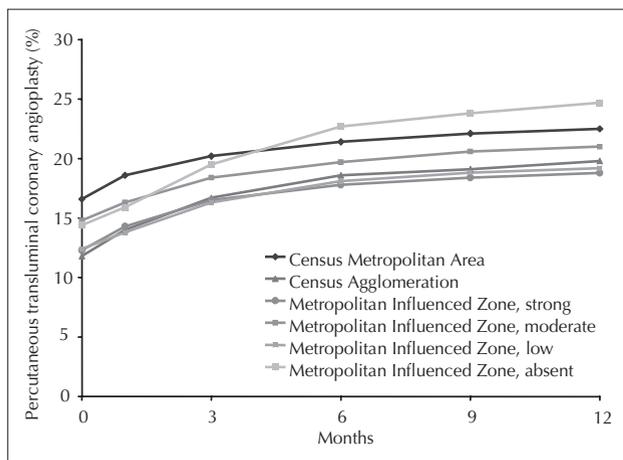
enced Zone, absent) are mostly located in the northern areas of the province (Côte-Nord and Nord du Québec), where the population differs from the rest of the province in its higher proportion of Aboriginals and predominance of resource-based industries (hydroelectricity, mining, forestry, etc.). Care management strategies for MI are likely to be different because of the particular health services resources and workforce.

MI incidence

We observed a higher incidence of MI in rural areas, compared with large urban centres. However, studies using other definitions of rurality have reached different conclusions. Some have reported a higher incidence of MI in rural settings,[13,38] while Martinez and colleagues, who studied the prevalence of chronic diseases by SAC between 1998 and 2000, found a higher rate of CVD in urban environments.[17] However, our methodology differs from that used by Martinez and colleagues since we examined only infarctions in patients who had not been hospitalized for this pathology in the previous year.

In a broad sense, CVD includes MI but also includes all chronic ischemic diseases such as stable and unstable angina and their consequences (e.g., heart failure). That urban populations have a higher prevalence of CVD while still having a lower incidence of "new" infarctions raises certain hypotheses, such as that individuals with active CVD migrate to large urban centres to be closer to specialized medical services or family, and that higher rates of chronic disease but fewer acute

Fig. 2. Age- and sex-adjusted rates (%) of percutanous transluminal coronary angioplasty among patients who were alive at 12-month follow-up ($n = 30\ 013$). The difference between the Statistical Area Classification is statistically significant at all time periods considered ($p < 0.05$).
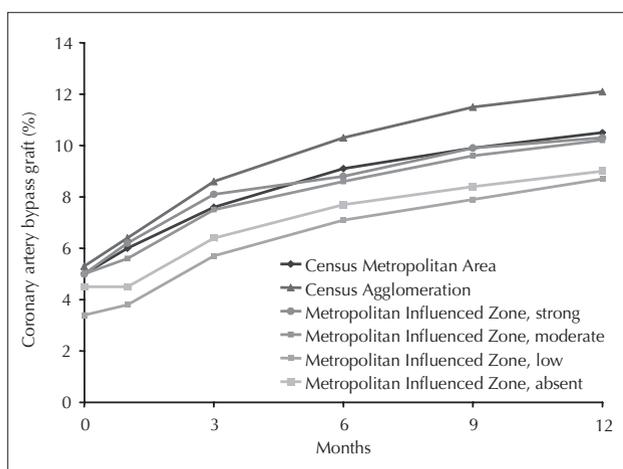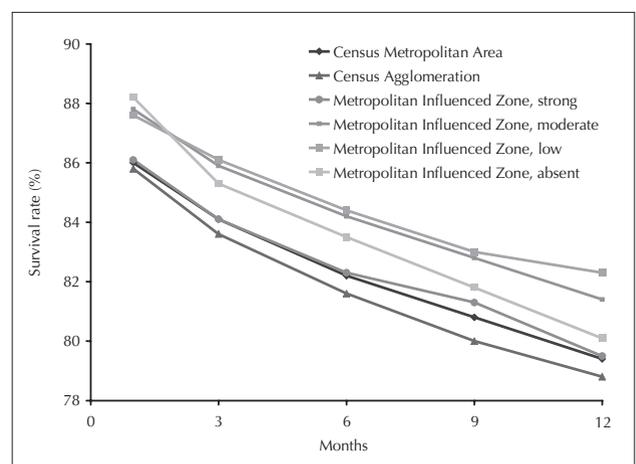

Fig. 3. Age- and sex-adjusted rates (%) of coronary artery bypass graft surgery among patients who were alive at 12-month follow-up ($n = 30\ 013$). The difference between the Statistical Area Classification is statistically significant at all time periods considered ($p < 0.05$).

Fig. 4. Age- and sex-adjusted survival rates (%) after myocardial infarction ($n = 37\ 678$) The difference between the Statistical Area Classification is statistically significant at all time periods considered ($p < 0.05$).

events indicate effective secondary prevention in urban environments.

Martinez and colleagues[17] presented higher rates of smoking, physical inactivity and obesity in rural areas—all major risk factors for MI—which may account for the higher rates of acute MI in these areas. Links between socioeconomic status and MI have been previously reported.[12,39,40] As presented in our study, rural populations are economically disadvantaged, which could be another explanation for this observation. Finally, it is possible that the MI incidence in rural areas was underestimated by not accounting for prehospital deaths. The fatality rates for MI can be as high as 30%, and over one-half of these deaths occur before the patients' arrival at the hospital.[41] Longer delay before starting reperfusion because of greater distance from the hospital[42] and admission to smaller hospitals[43] can influence this outcome.

Revascularization

Postinfarction PTCA rates are higher in the large urban hospitals, which is not surprising considering that this procedure is available only in specialized cardiology centres. These results came from a 1995–1997 cohort study. PTCA, as first intent treatment, has been given much greater priority in recent years.[11] According to Health Canada, the number of angioplasties done in Canada increased over 35% between 1994–1995 and 2000–2001.[44] Today, the discrepancy between urban and rural areas must be even greater since the procedure requires quick intervention, which should logically favour people living close to a specialized cardiology centre.

Unlike PTCA, CABG is used equally in urban and rural areas, although this procedure is exclusively available in specialized cardiology centres. Bypasses, however, are not usually performed during the acute phase, thus distance from the care centre is less of a limiting factor.

As aforementioned, MI prognosis depends on how quickly reperfusion is initiated. PTCA is the preferred method and its use is correlated with its availability at the admitting hospital.[41,45,46] Previous results show that although invasive procedures reduce morbidity (nonfatal outcomes) and enhance quality of life,[45,47,48] their availability at the admitting hospital has no effect on postinfarction survival.[49,50] The results of our study are consistent with these findings since the survival rate of individuals living in metropolitan areas is not better than those living in nonmetropolitan areas.

Accessibility of services

These results raise the issue of the accessibility to specialized services in more remote regions. The point has been made many times that availability of these services in the hospital initially admitting the patient, as well as the proximity of these services, are factors that determine their use.[45,49,51] Thus patients from rural areas are disadvantaged with regard to their likelihood of getting a diagnosis or benefit from an invasive therapeutic procedure.[52] The fact that they have to wait longer for these procedures than their urban counterparts is another disadvantage.[53] The higher rates of PTCA found in rural areas with moderate metropolitan influence or no urban influence is intriguing and may reflect standardized transportation protocols (i.e., medevac and ambulance) that facilitate direct transportation to a specialized cardiology centre rather than to a local hospital.

The challenge of defining rural

Choosing a definition of rurality is a challenge for researchers in health fields since it has an impact on the interpretation and comparison of data. The SAC has many conceptual and practical advantages, compared with other definitions of rurality. First, this definition was developed in Canada and is therefore more applicable to our study. Second, the fact that Statistics Canada developed the SAC and uses census geography as the analysis unit enables researchers to access vast amounts of administrative and socioeconomic data. Among the different classifications proposed by Statistics Canada, the SAC uses one of the smallest geographic study areas (Census Subdivision),[23] which makes it more precise. Moreover, this definition is not limited to an urban–rural dichotomous classification but permits variability within each area. The SAC is the only definition that incorporates a functional criterion: commuting. This concept is not restricted simply to home–work travel; rather, it reflects regional, social and economic integration since it has been shown that commuters are looking for more goods and services in the vicinity of their workplace (e.g., shopping and daycare).[53,54]

Our cohort study has the strength to include the entire province of Québec, which is interesting from a public health perspective since it provides province-based knowledge, incorporating geographic variables of an important health problem. In the long term, this may contribute to improving prevention and intervention programs.

Limitations

Our data analyses did not account for out-of-province procedures. This may lead to an underestimation of procedures for regions like Ottawa–Hull, where the population of the Outaouais region has easy access to the Ottawa Heart Institute located in the province of Ontario. However, this phenomenon is unlikely to appear along the borders of the United States and New Brunswick as there are no specialized cardiac centres near those borders. We also believe that this phenomenon will have a limited impact on our analyses as the population was divided according to the SAC and not the administrative region.

Like the incidence rate, the survival rate should be interpreted with caution because of the exclusion of prehospital deaths from our sample. In fact, as previously discussed, patients with more severe MI have more chance of reaching a hospital alive in urban than in rural areas. Thus it is possible that the cases included in our cohort for the urban areas were more severe than those in the rural areas and from the outset had a worse prognosis, which might explain the negligible difference in the mortality rates.

CONCLUSION

Rurality is an important field of research. Socioeconomic and health disparities found between urban and rural areas raise a variety of questions among researchers and decision-makers. This study revealed geographic heterogeneities of MI incidence, revascularization rates and survival rates among urban and rural populations. Factors such as rural populations' low socioeconomic status and limited accessibility to health care can explain these disparities. However, questions remain regarding other aspects of MI care management, including transportation and planning for the initial treatment of these patients.

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