THE SOCIAL GEOGRAPHY OF CHILDHOOD MORTALITY IN TORONTO, ONTARIO, 1901: PATTERNS AND DETERMINANTS

By

MICHAEL E. MERCIER, B.Sc. (Hons), M.A.

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AUTHOR: Michael E. Mercier, B.Sc. (Hons) (Trent University, M.A. (Carleton University)

SUPERVISOR: Professor Richard Harris

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ABSTRACT

This thesis investigates the patterns and causes of childhood mortality in turn of the twentieth century Ontario and Toronto, Canada. There is growing emphasis in the historical demography and geography literature on the trends and spatial variations, as well as the determinants, of childhood mortality (deaths of children under the age of five). However, our understanding of these issues, and in particular the patterns and determinants within specific places, is limited by restrictions on the accessibility of individual-level data. This research focuses on documenting and explaining patterns of childhood mortality at three scales: the city/region, the neighbourhood, and the individual household. Using a case study approach, aggregate infant mortality rates for cities in Ontario between 1881-1941 were documented at five year intervals. Contrary to expectations, city size, population density and household crowding did not explain the variation in urban mortality rates. Instead, the socio-cultural composition of the population explained the greatest share of the mortality variation at the inter-urban scale. Analyses of Toronto in 1901 at the individual household and neighbourhood scales utilise data collected from individual-level death records, which were manually linked to the manuscript Census of Canada and tax assessment rolls. Results of the household level bivariate analyses reveal that social class (assessed value of home), housing conditions (crowding) and socio-cultural affiliation (religion, nativity, ethnicity) were independently associated with childhood mortality. Multivariate analysis confirmed these findings, and pointed to the importance of religion and crowding in particular. At the

neighbourhood scale, analysis of the social geography of Toronto indicated a greater level of residential segregation by ethnicity and religion than previously understood. Childhood mortality varied a good deal from one neighbourhood to another, but not in the expected or predicted ways. Mortality rates were equally high in suburban fringe areas and inner city slums, and these variations could not be explained by social class or housing conditions, rather cultural affiliation had the strongest influence. In this regard, cultural background, but not necessarily immigrant status, was the most important determinant of mortality patterns at all three scales of analysis.

DEDICATION

This thesis is dedicated to two people, my father, Ernest C. Mercier, who would be so proud to see this finished, and my son, Graham J. R. Mercier, who has waited so patiently for Daddy to finish his 'PhD book'. This is for you both. I love you.

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for their dedicated work as members of my supervisory committee. I have gained great insight into many aspects of this thesis from conversations with colleagues both near and far, and included among this group are David Wright, Christopher Boone and Pat Thornton in particular.

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PREFACE

This dissertation is a compilation of three research papers that have either been submitted, or soon will be submitted, for publication. The three substantive chapters of the thesis, Chapters 2-4, correspond to these research papers. Chapter 1, the introduction, sets the context for the dissertation research, establishes the theoretical background, outlines the research design, data sources and methodology, and discusses the overall objectives of the research. Chapter 5, the conclusion, summarizes the findings of the research, and discusses the theoretical and methodological contributions of the dissertation, and forwards a number of potentially fruitful avenues for future research. Each of the papers were written in a slightly different format in order to satisfy the stylistic requirements of each journal. Because each chapter represents an independent research paper, some repetition is inevitable, especially in the review of literature and discussion of data sources and methods. The substantive research papers are as follows:

CHAPTER 2:
Mercier, Michael E., 2003, Infant Mortality in Ontario, 1881-1941: An Inter-Urban Analysis of a Period of Decline. Submitted to *Urban History*.

CHAPTER 3:
Mercier, Michael E., 2003, The Determinants of Infant and Child Mortality in Toronto, 1901. For submission to *Population Studies*.

CHAPTER 4:
Mercier, Michael E., 2003, The Social Geography of Childhood Mortality, Toronto, 1901. For submission to *Urban Geography*.

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CHAPTER 1: INTRODUCTION

> Ontario should take up this cause. There is not very much difference between the murderer and the one who stands by and sees those die whom he could save. The infant mortality rate must be reduced, beginning in the cities. (MacMurchy, 1911, p.54)

1.1 - INTRODUCTION

Through nineteenth century accounts, and the later writings of historians and geographers, we have become accustomed to thinking of slums and suburbs as opposite poles on a health continuum that extended from inner-city slums of disease and death to suburban paradises of healthfulness. In truth, such beliefs are poorly grounded in fact (Harris and Mercier, forthcoming). In much the same way, contemporaries assumed that an individual's health was generally a reflection of their social standing, or in the case of immigrants, their poor genetic stock (MacMurchy, 1910; Meckel, 1990). These assumptions are also poorly grounded in fact. The paucity of historical studies exploring the geography of mortality at the scale of the city, the neighbourhood or the individual household means that we do not really know which places were healthy and which were not, nor have we established what the determinants of individual health were. The purpose of this thesis is to document and explain the incidence of childhood mortality, as this varied among cities in Ontario, and among neighbourhoods and households in Toronto in 1901.

In the nineteenth century, one in four babies would die before their first birthday, and in some particularly unhealthy cities half of all babies died in their first year. In 1901, almost 5500 infants died in Ontario before their first birthday (Registrar General, 1903). Additionally, the issue of urban health, and particularly infant health, was of great concern to doctors, public health officials, government leaders and the general public in the late nineteenth and early twentieth centuries, and many called for action (MacMurchy, 1912). One such call, by the prominent Canadian physician and reformer Helen MacMurchy, opens this chapter. The usual responses included various public health and urban reform initiatives, including housing and tenement reform, sanitation infrastructure development, vaccination, inoculation and health education programs, and food, milk and water quality inspections. Given the weight of such human loss, and the importance placed on the issue by contemporaries, it is surprising how little attention the topic has garnered from scholars and, as a result, how little we understand about the determinants and spatial variability of urban health in the past.

The most commonly used measure of community health is the infant mortality rate (IMR) which measures the number of infant deaths (under age one) per 1000 live births in a given year. The IMR is important because of its particular sensitivity to social, economic and environmental conditions (Ogden, 1994). Infants, as well as children between the ages

of one and five, are among the most vulnerable to infectious illnesses which are, in turn, influenced by poor social and living conditions. This sensitivity to social and environmental conditions has led the infant mortality rate to be widely used in the demographic, health, and urban literature as a proxy for the social and environmental conditions in which infants and their families lived (Preston and Haines, 1991; Thornton and Olson, 1991, Beaver, 1973, Mooney, 1994).

While it is difficult to find national infant mortality rates for any one particular point in time, **Table 1.1** shows IMR for a few select countries around the turn of the century. Canada's IMR lies approximately midway between the highest and lowest rates of these select countries. At the end of the nineteenth century, of the 40 North American cities with a population greater than 100 000, IMRs ranged from 95 in Minneapolis to about 285 in Montreal, with an average of 170 (Meckel, 1990; U.S. Census Bureau, 1901) (**Table 1.2**). Among this group of cities, Toronto was about average in terms of population at 208 000 (ranked 18th), and infant mortality (167). Compared to North American urban places of all sizes, however, Toronto was considered large, and relatively unhealthy, as measured by its infant mortality rate (McInnis, 2000a). By Canadian urban standards, Toronto's infant mortality rate was high, but markedly lower than many of the cities in Quebec. While data for other Canadian cities are sparse, places in Francophone Canada had notably high infant

mortality rates (McInnis, 2000a). For example, in Montreal and Quebec City, the two largest Francophone Canadian cities, one in four infants died in their first year, even well into the twentieth century when rates everywhere had begun to decline. In Ontario, where mortality rates were generally lower, IMRs were published for 24 cities in 1901, with an average of 162, and ranging from 74 (Owen Sound) to 292 for Ottawa (Registrar General, 1903).

An important and neglected topic, childhood mortality in Ontario and Toronto at the turn of the twentieth century is the focus of this thesis. More specifically, the thesis documents and explains the trends and spatial patterns of infant mortality at the urban scale for the province of Ontario, and the causes (determinants) and patterns of childhood mortality at the neighbourhood and individual household scales for the city of Toronto in 1901.

1.2 - THEORETICAL CONCEPTUALIZATION

The Epidemiological Transition Model (ETM) describes, theoretically, how the mortality regime of societies change from one dominated by infectious and parasitic diseases to one characterized by human-made and chronic conditions (Curtis and Taket, 1996; Omran, 1971; Trovato, 1994). The model is comprised of three stages of epidemiological

change: the era of pestilence and famine, the era of receding pandemics and the era of human-made and degenerative diseases. In the eighteenth century, the gradual disappearance of pandemic mortality from such infectious diseases as bubonic plague and small-pox meant that European society had moved from the era of pestilence and famine to one of receding pandemics (Livi-Bacci, 1997; Curtis and Taket, 1996). The pace and scale of industrialization and urbanization of Europe and North America in the nineteenth century contributed to generally high, though less volatile, mortality from endemic infectious diseases such as diphtheria, typhoid, pneumonia, cholera, and tuberculosis (Lancaster, 1990; Woods, 2000). Only through more efficient government intervention beginning towards the end of the nineteenth century did developed countries begin to see a secular decline of mortality rates, especially in cities and among infants and children (McKeown, 1979; Porter, 1997; Szreter, 1988). While the pattern of mortality decline was relatively consistent among developed countries, the decline in infant and child mortality in Canada and the United States may have occurred somewhat later, and more quickly, than in Europe (Alter, 1997; Haines and Steckel, 2000).

One significant weakness of the ETM is that the use of nations as the units of analysis mask the differential experience of this mortality transition among different regions, places and population subgroups (Barrett et al, 1998). For instance, the marked differential

mortality experience of urban and rural places, especially during the urbanizing nineteenth century is not considered by the ETM. In the same way, the differential experience of specific urban places, or even neighbourhoods within cities, as public health services were introduced, does not get consideration under such a model. In light of this, while population health research still often takes an ecological-level perspective to mortality regimes, there is a need for more focussed perspectives as well (Gatrell, 2002; Wilkinson, 1996). In this thesis, three different scales of analysis are used: the regional/urban system of Ontario, the neighbourhood, and the individual household.

While historical demographers and geographers have placed great emphasis on documenting the timing, and causes, of this mortality transition, some have also concerned themselves with spatial variations of mortality. While comparisons have been made between different countries, comparability of data has made this a challenge (Corsini et al, 1997). As a result, relatively more attention has been directed at explaining inter-regional variations. Comprehensive studies of inter-regional variations of infant and child mortality in European countries have dominated this work (Woods and Shelton, 1997; Vogele, 1998; Reher, 1997; Wolleswinkel-van den Bosch et al, 2000). The most important finding of these studies is the existence, in the nineteenth and early twentieth centuries, of a persistent urban and rural mortality differential (Bairoch, 1988). This excess urban mortality was attributable

to infectious diarrhoeal diseases which were many times higher in the cities than the countryside (Williams and Galley, 1995). Similar assessments of North America have confirmed the existence, and magnitude, of this differential (Condran and Crimmins, 1980; McInnis, 1997). In addition to urban and rural differences, many demographic histories have also documented variations between individual cities, whether in Europe or North America (Bairoch, 1988; Meckel, 1990; Alter, 1997).

In general, three broad factors have been associated with mortality levels for specific places: environmental conditions, socio-economic circumstances, and socio-cultural differences. Environmental conditions have been identified as an important determinant of mortality levels. A central component of the argument for the significance of urban and rural mortality differentials is the deleterious environmental conditions of urban places, especially in the industrialising nineteenth and early twentieth centuries (Woods and Shelton, 1997). For England and Wales, Woods (2000) has demonstrated the importance that density, as a measure of the urban-sanitary environment, had on infant and child mortality rates. In North America, the focus has been more on levels of crowding within the home, as opposed to density surrounding the home. For example, Woodbury (1925) found that crowding, even after controlling for material circumstances, elevated levels of mortality by a factor of two in early twentieth century American cities. Whether the measure used is

population density or internal crowding, in either case the relationship with mortality is clear. When greater numbers of people congregate in close proximity, the risk of infectious diseases spreading is high. The most vulnerable population to such infections are the very young. As a result, the accumulation of large numbers of people into cities, and increased rates of crowding, contributed to higher levels of infant and child mortality.

Inspired by the conclusions of McKeown (1979) that gains in overall standard of living were the driving force behind mortality decline in England and Wales, many historical demographers have examined the importance of socio-economic factors as determinants of levels of infant and child mortality. Most prominent among these factors is social class. For England and Wales, where the data is comparatively rich, the evidence of a mortality gradient by social class is clear. Those at the upper end of the occupationally-based social class hierarchy had much lower levels of mortality than the working class (Haines, 1995; Woods et al, 1988). In addition to the issues of standard of living and the importance of social class, the importance of maternal employment to mortality levels has also garnered a great deal of attention by historical demographers. Contemporaries agitated about the negative impact that maternal employment had on the health of children, but the results of recent enquiries are more equivocal. On the one hand, mothers working outside the home were generally unable to breastfeed their infants, and therefore, through artificial feeding

methods they inadvertently increased the infant's risk of exposure to contaminated milk and water and thus, gastro-intestinal pathogens. On the other hand, had mothers not ventured out of the home to seek employment and not brought home much needed family income, mortality rates, especially among the working class may have been much higher (Graham, 1994; Holdsworth, 1997; Dyhouse, 1978; Garrett, 1998).

While breastfeeding has been shown to be critically important to levels of infant mortality in the nineteenth and early twentieth centuries, much of the debate about which mothers breastfed and which did not has been, especially in North America, focussed on differences between socio-cultural groups rather than socio-economic ones (Preston and Haines, 1991). The reason for the focus on breastfeeding stems from the observed mortality differentials between socio-cultural groups and the documented differences in breastfeeding rates among these groups in the U.S. (Woodbury 1925). Woodbury's account of mortality in American cities highlighted the importance of socio-cultural differences to infant mortality rates, with infants of Polish, Portugese and French-Canadian ancestry at the upper extreme, and Jewish at the lower. While social class was undoubtedly an important determinant of child mortality in late nineteenth century America, race and nationality were seemingly more important (Preston and Haines, 1991). In Canada, the same conclusions have been drawn about the extremely high infant mortality rates of French-Canadians in the

late nineteenth and early twentieth century (Thornton and Olson, 2001; Mercier and Boone, 2002; McInnis, 1997; McInnis, 2000a; McInnis, 2000b).

Alongside race and nativity among socio-cultural determinants, religious affiliation has also been found to be an important marker for groups with high or low infant and child mortality rates. Highlighting this are the examples of French-Canadians, overwhelmingly Catholic, on the one hand, and Jews on the other. In both North America and Europe, Jews consistently had the lowest levels of mortality of any socio-cultural group despite often living in the worst sanitary environments and being near the bottom of the social hierarchy (Condran and Kramarow, 1991; Marks, 1994). The factors most often attributed to differences in infant and child mortality rates by socio-cultural affiliation are breastfeeding, hygienic practices within the home (ie. frequency of bathing and regular hand washing), food preparation, and fertility practices (ie. birth intervals, sibship size, rapid replacement of children that die).

In general, different determinants of childhood mortality have been identified through analyses at varying scales. Environmental conditions, for example, as measured by population density, urban-rural character, and city size have been associated with childhood mortality at the inter-urban scale, while household crowding, on the other hand, is more

often thought to influence mortality at the neighbourhood or household level. Additionally, social class does not vary much among cities, but does between individuals and even neighbourhoods, and so it is reasonable to expect that the influence of class would be greater at the household scale than the inter-urban. Finally, cultural characteristics vary between individuals, neighbourhoods (through residential patterns) and even cities, so we might, therefore, expect cultural variations to influence childhood mortality at all three spatial scales.

1.3 - RESEARCH OBJECTIVES

Emerging from this literature, therefore, are three key objectives for this thesis. To document and explain the patterns of childhood mortality at three different spatial scales: the city, the neighbourhood and the individual household. Each objective, therefore, is addressed through a different case study. Objective 1 is met through a case study of Ontario cities between 1881-1941 (Chapter 2), and objectives 2 and 3 are addressed through case studies of Toronto in 1901 utilising individual household level data (Chapters 3 and 4). Chapter 3 focusses on the patterns and determinants of childhood mortality of individual households, while Chapter 4 is concerned with the social geographic patterns and causes of childhood mortality at the scale of the neighbourhood.

1.4 - THE LOCAL CONTEXT

Ontario's urban system contains cities of varying sizes and is characterised by a unique type of cultural diversity, making it an appropriate case study for an analysis of mortality variation. Largely an Anglophone province, Ontario had a number of cities with a strong French-Canadian minority. Additionally, Ontario contained urban centres of varying sizes, though the majority were quite small. According to the Canadian Census criterion (population of 5000), there were two dozen urban places in 1881, rising to 35 by 1911. The median population size was 7741 in 1881, rising to 10 770 in 1911, and 17 369 in 1941, an increase of 125% over 60 years. Growth in both number and size of urban areas indicates that Ontario was urbanising at a rapid rate during this period, though like elsewhere, the greatest growth occurred in the province's largest cities. In 1881, a sixth of Ontario residents lived in cities, and by 1911 the urban share of population had reached a third. By 1941 nearly a half of Ontario's population was urban. Within Ontario, significant variation exists between cities in terms of size, density, crowding, economic and political function, and cultural composition.

In 1901, Toronto was Canada's second largest city and among the twenty largest cities in North America (Careless, 1984; U.S. Census Bureau, 1901). Toronto's initial

success as a community was tied to its role as the seat of government for the province of Ontario, but its protective harbour and strategic location as an access point to the Upper Great Lakes and the U.S. mid-west also contributed to its growth in the nineteenth century. The city's economy was driven, in varying proportions over time, by banking, wholesale and retail trade, and industrial production that thrived on its role as the capital of Anglophone Canada (Careless, 1984).

Toronto's growth in the nineteenth century was driven by waves of, mostly British and Irish immigrants. The largest rates of growth occurred in the early nineteenth century when the city's population increased from less than two thousand to over thirty thousand in a thirty year period. The largest absolute population surge occurred in the 1880s when 95 000 immigrants swelled the city's population. Then, slowed by a global depression, the rate of growth of Toronto slowed to a trickle in the 1890s when the population grew by only 15% (Careless, 1984). From the outset the city was established by British immigrants, but Catholic Irish fleeing the famine in the 1840s and 1850s altered the social composition of the city (Careless, 1984). Continued British immigration in the following decades meant that, by 1901 greater than ninety percent of the population was of British or Irish ancestry, and eighty percent were Protestant. Aside from an Irish Catholic population which accounted for eight percent of the total, the city also contained very small minority groups

of French, German, Dutch, Italian and eastern European Jewish ancestry.

In the nineteenth century, the city's residential landscape, like other North American cities of the period, was radically altered by the influences of industrialisation and urbanisation. Together, these forces contributed to a residential pattern that by 1900 was determined quite strongly by occupational class (Goheen, 1970). Middle- and upper-class residential areas had emerged in several areas of the city, while working-class areas, marked by dilapidated housing, inadequate sanitary services, and poverty existed both in the city's central core and on the urban periphery. At the same time, residential patterns did reflect cultural affiliation, though to a lesser degree than occupation, most notably among recent non-British immigrants in the city's central slum, and Catholic-Irish in several distinct residential clusters. In 1901, therefore, the social geography of Toronto was determined mainly by class, though some segregation by socio-cultural affiliation existed.

1.5 - OVERALL RESEARCH DESIGN, DATA & METHODS

Mortality data was collected at two separate spatial scales to meet the three research objectives. Objective 1, addressed in Chapter 2, required aggregate-level published birth and death data for individual urban communities, and rural counties. These data were collected

in five year intervals for a sixty year period (1881-1941) from the published annual Register of Births, Marriages, and Deaths for Ontario's 35 urban communities and 55 rural counties. Registration data were supplemented with information on the physical size of the city (in acres), measures of internal household crowding, and the ethnic composition of each city and county from the decennial Census of Canada.

For the household and neighbourhood-scale analyses reported in Chapters 3 and 4, a complete enumeration of the infant and child deaths in Toronto in 1901 was made from the death register located at the Provincial Archives of Ontario. The following information was collected for each of the 935 infants and children: name, age at death, religion, father's name, doctor's name, place of residence, and date and cause of death. Utilising the methods of record-linkage, each of the deaths were linked to the 1901 manuscript Census of Canada and to the 1901 municipal tax assessment rolls in order to reconstruct the socio-cultural, socio-economic and environmental (housing) conditions in which the infant had lived and died. In addition to the data extracted from the death records, the census and assessments provided information on the demographic characteristics of the family and household (ie. family size, number of children, presence of boarders), the occupation and earnings of the household head, the socio-cultural background of the parents (ie. ethnicity, religion, nativity), and the size and value of the family home. In some cases, additional sources such

as the annual city directories (1897-1903) and the 1899 fire insurance atlas were used to help reduce the number of cases that remained untraceable. All told, 661 deaths (481 infants and 180 children) were eventually traced to the Census and Assessment rolls; a success rate of 71%.

In order to assess the importance of specific factors to the death of the infants and children, it was necessary to construct a similar database for a sample of the general population. The Canadian Families Project (CFP) data, now widely available, is a stratified five percent national sample of the 1901 Canadian Census. The CFP sample data for Toronto, supplemented with tax assessment information by the author, became the control population for the analysis. The sample is spatially, and otherwise, representative of Toronto's general population.

1.6 - CHAPTER OUTLINE

The three substantive chapters of this thesis (Chapters 2-4) describe the central components of the overall research project, and are stand-alone papers intended for journal publication. Each has been submitted (or will very soon be) for review to a scholarly journal. These chapters are organized in the following way.

Chapter 2 addresses gaps in both the demographic and urban history literature by documenting the temporal and spatial patterns of Ontario's infant mortality rates through a period of mortality decline, 1881-1941. For a region and time period that has been largely neglected by demographic historians, Chapter 2 documents both the provincial trend and the extent of the urban-rural differential for infant mortality rates. The results of the analysis confirm that infant mortality rates in Ontario declined, approximately at the same time as in the United States and Europe, and that the urban-rural mortality differential was as significant and persistent in Ontario as these other jurisdictions. It was not until the 1920s that urban and rural infant mortality rates were equal.

In addition, Chapter 2 attempts to explain urban variations in childhood mortality in terms of city size, population density, household crowding, and the socio-cultural composition of the population. It reports that city size, population density, and household crowding do not satisfactorily explain the urban variation in mortality rates, rather, the socio-cultural composition of the population, and in particular the proportion of the urban population that is French-Canadian, explains the greatest share of the pattern. Consistent with the findings of other Canadian research as well as an emerging international literature, this finding highlights the importance, at the aggregate-level, of socio-cultural difference, and perhaps related cultural practices.

In Chapter 3 the focus on mortality shifts from a broad regional perspective to the level of the individual household. Utilising individual-level archival data sources (death records, Census returns, property tax assessment rolls) Chapter 3 explores the determinants of infant and child mortality. In particular, the analytical focus of the chapter is, initially, on assessing the independent importance of factors such as occupation, housing type and size, crowding, family size, socio-economic class, ethnicity, nativity, and religion through bivariate analyses. Having established the independent importance of several of these factors, their relative importance are assessed through multivariate analysis. Though the conclusions remain tentative, it seems that alongside fertility, socio-cultural affiliation, as best defined by religion and nativity, and measures of household crowding and structure are the most important determinants of childhood mortality among households in Toronto in 1901.

The final substantive chapter of the thesis, Chapter 4, takes a social geographic perspective and, building on the findings of Chapter 3, assesses the importance of measures of class, housing and culture to the explanation of neighbourhood variations of childhood mortality. Using neighbourhoods as the unit of analysis, the spatial pattern of high levels of internal household crowding, concentrations of poor homes, and religious affiliation are established, and these findings are situated within the broader historical social geographic

literature of Toronto. Then, following a documentation of the geography of childhood deaths at the neighbourhood level, mortality rates are correlated with neighbourhood attributes of class, housing and culture. While only about a third of the neighbourhood mortality variation is explained by these, the most important determinants of mortality at the household scale, the importance of cultural background, as expressed through religion and family ancestry, is found to be of paramount importance, a finding that emerged consistently through all three scales of analysis in the thesis.

A final concluding chapter draws together the findings of the three substantive papers, and provides summary remarks regarding the results and their implications. The thesis ends with a discussion of areas for further research which emerged through the overall project.

Table 1.1 - Infant Mortality Rates (IMR), Select Developed Countries, 1900-01

	IMR		IMR		IMR
Austria	209	Italy	166	Canada	154
Belgium	143	Netherlands	149	United States (White)	111
Denmark	136	Norway	91	United States (Black)	170
England & Wales	151	Russia	272	Mexico	220
Finland	145	Scotland	129		
France	143	Spain	185	Australia	96
Germany	207	Sweden	103	New Zealand	81
Ireland	101	Switzerland	137		

(Sources: Europe: Mitchell, 1992; Australasia: Lancaster, 1990; North America: Haines and Steckel, 2000)

Table 1.2 - Infant Mortality Rates (IMR), Select North American Cities, 1900-01

	IMR		IMR		IMR
Atlanta	259	Milwaukee	168	Ottawa	292
Washington DC	233	Cleveland	164	Kingston	239
Baltimore	205	Philadelphia	162	Toronto	167
New Orleans	198	Los Angeles	154	Hamilton	152
Providence	190	Buffalo	137	Montreal*	285
Detroit	177	San Francisco	136	Quebec City*	275
Boston	173	Chicago	134	Halifax*	185
New York	171	Minneapolis	95	Vancouver*	125

(Sources: United States: Meckel, 1990; Ontario: Registrar General, 1903; Other Canada: McInnis, 1990) Note: * for 1891.

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CHAPTER 2: INFANT MORTALITY IN ONTARIO, 1881-1941: AN INTER-URBAN ANALYSIS OF A PERIOD OF DECLINE

2.1 - INTRODUCTION

In the nineteenth century, one in four babies would die before their first birthday; in some particularly unhealthy cities half of all babies died in their first year. By the 1920s this rate had declined to one in ten. Today, in most developed countries, the odds of infants dying in their first year are about one in two hundred, whereas in some developing countries, the infant mortality rate (IMR) today is comparable to that of developed countries of nearly a century ago. Research on developing countries commonly focusses on the mortality rates of infants and children because, of all sub-groups of the population, they are the most sensitive to poor environmental and living conditions. The infant mortality rate is, therefore, widely accepted as a sensitive indicator of living standards and overall community health. Historically, the issue of urban health, and particularly infant health, was of great concern. In the nineteenth and early twentieth centuries, doctors, public health officials, reformers, newspaper editors, and government leaders in Canada and elsewhere expressed concern over high infant mortality rates and called for action. This onslaught included various public health and urban reform initiatives such as, housing and tenement reform, sanitation infrastructure development, vaccination and inoculation programs, and food, milk and water quality inspections. Given the significance of such human loss, and the importance placed

on the issue by contemporaries, it is surprising how little attention urban historians, and historical geographers, have given the topic, and therefore, how little we understand about the spatial variability of urban health in the past.

Most of what we know about historical mortality trends and spatial patterns comes from European evidence; there is little published material which documents trends or geographical patterns for North America. As a result, scholars have assumed that North American mortality rates behaved similarly to those of Europe. Given differences in the rates and timing of urbanisation and industrialisation, variations in cultural practices, and differences in the role of governments, this assumption can be challenged.[1] North American analyses at the regional and local scales, therefore, are needed not only for their contributions to demographic history via our understanding of the spatial variation and timing of mortality decline, but also for their contributions to urban history through an appreciation for the experiences of people living in individual cities, especially with how these experiences relate to health.

This paper addresses several gaps in the urban and demographic history literature.

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1 For an illustrative discussion of differences between 'Old World' and 'New', see, L. Frost, *The New Urban Frontier: Urbanisation and City-Building in Australasia and the American West* (Kensington, Australia, 1991).

infant mortality, and in so doing both supports and contradicts the findings of American and European research on the important determinants of inter-urban and regional differences in infant mortality rates. In so doing, this paper fills a substantial gap in the urban history literature, that being, the connections between ecological urban characteristics and mortality rates.

2.2 - TRENDS AND VARIATIONS IN URBAN HEALTH

Few writers have sought to explain trends, and especially spatial variations, in urban health for the nineteenth and early twentieth centuries.[3] However, contemporaries, faced with a continued deterioration of living conditions in North American cities, were vocal in their call for change. In North America, as in Europe, the economic transition of the Industrial Revolution stimulated a change in the social geography of cities. Cities metamorphosised from a pre-industrial 'pedestrian' form to a 'modern' industrial one. The growth in number and size of cities, increased industrial activity, and the emergence of horse-powered transit systems, and their concomitant filth, pollution, and congestion in the

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3 Health geographers, especially those espousing the population health perspective, have sought to explain trends, and spatial variations, of twentieth century mortality and morbidity. For example, see, S. Curtis and A Taket, *Health and Societies: Changing Perspectives* (London, 1996); A. Gatrell, *Geographies of Health: An Introduction* (Oxford, 2002); R. Wilkinson, *Unhealthy Societies: The Afflictions of Inequality* (New York, 1996).

centre of the city encouraged the wealthy and upper-middle classes to escape the city. Increased industrial, commercial, and political demands on land in the core of the city placed ever greater pressure on the housing stock of the poor and working-classes. Rapid urbanisation, driven mostly by working-class immigrants and rural migrants further exacerbated these housing shortages. By the turn of the twentieth century contemporaries were concerned about the healthfulness of cities, and established public health, housing, and political reform movements.

Contemporaries were concerned about the links between housing conditions, sanitary infrastructure, crowding and health. Countless sanitary reports in the late nineteenth and early twentieth centuries by medical officers of health and other reformers stressed the need to eliminate tenements, improve water quality, and provide sewerage because of their impact on health, and especially death rates.[4] Contemporaries such as social scientist Adna Weber went to great lengths to establish the connections between urban characteristics such as high

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[4] The public health boards of many cities produced annual reports from the mid-nineteenth century onwards. In addition to these, occasional and more substantive studies were conducted. For example, see, J. Griscom, *The Sanitary Condition of the Laboring Population of New York* (New York, 1845); C. Hastings, *Report of the Medical Health Officer Dealing with the Recent Investigation of Slum Conditions in Toronto* (Toronto, 1911); C. Hodgetts, *Unsanitary Housing* (Ottawa, 1911); C. Wright, *The Slums of Baltimore, Chicago, New York and Philadelphia* (New York, 1892); Citizens Association of New York, *Report Upon the Sanitary Condition of the City* (New York, 1866).

population density and internal household crowding and death rates.[5] Weber's analysis of 1890 New England revealed a substantial urban-rural mortality differential; mortality rates were as much as twenty percent higher in cities than in the countryside.[6] Indeed, a mortality gradient was evident such that the larger the city, the higher the mortality rate. The relationship between urban and rural mortality rates was consistent for all age groups, though evidence from the 1890 United States Death Registration Area[7] showed that the most severe 'urban penalty' was for infants and young children for whom mortality was more than twice as high in the cities.[8] Weber's analysis also confirmed the prevailing belief that death rates were higher in more densely populated cities, and cities with higher rates of internal household crowding.[9]

While contemporaries such as Weber noticed inter-urban variations in death rates,

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5 A.F. Weber, *The Growth of Cities in the Nineteenth Century* (Ithaca, 1899).

6 Weber, *Growth of Cities*, 344.

7 The Death Registration Area was created by the United States Census Bureau and was modified regularly when the vital statistics of individual states met certain reliability criteria. In 1890 the DRA included New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, and the District of Columbia. See, M. Haines, 'The white population of the United States, 1790-1920', in M. Haines and R. Steckel (eds.) *A Population History of North America* (New York, 2000), 311.

8 Weber, *Growth of Cities*, 346.

9 Weber, *Growth of Cities*, 345.

others were also concerned about conditions and variations within specific cities. In an 1890 journalistic expose of the tenement districts of New York, Riis calculated death rates for individual tenements and for the most crowded tenement districts such as the 'Bend' and 'Hell's Kitchen'.[10] For the Bend, a notorious crowded tenement district, Riis calculated the death rate to be 40 percent higher than for the rest of the city.[11] In Canada, contemporary reformers such as Montreal businessman Herbert Ames, were also well aware of the connections between death rates and urban characteristics such as housing, density, crowding and sanitation.[12] In Toronto, reform physician Helen MacMurchy laid the blame for Toronto's infant mortality rate squarely on the shoulders of the poor, and particularly immigrant mothers.[13] MacMurchy believed that high rates of infant mortality stemmed jointly from the living conditions of the poor (housing, sanitation, crowding) and the ignorance of mothers in the proper care and feeding of their children.

A recent survey of the urban and suburban literature of North American cities by

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10 J. Riis, *How the Other Half Lives: Studies Among the Tenements of New York* (New York, 1890:1957).

11 Riis, *How the Other Half Lives*, 47, 229.

12 For a thorough discussion of the findings of Ames see T. Copp, *The Anatomy of Poverty: The Condition of the Working Class in Montreal, 1897-1929* (Toronto, 1974).

13 H. MacMurchy, *Infant Mortality: A Special Report* (Toronto,1910); H. MacMurchy, *Infant Mortality: A Second Special Report* (Toronto, 1911); H. MacMurchy, *Infant Mortality: A Third Special Report* (Toronto, 1912).

Harris and Mercier revealed a remarkable dearth of work that actually documents the range of health conditions that existed in the diverse suburban communities of the late nineteenth and early twentieth centuries.[14] Given the recent re-interpretation of the suburban experience in North American cities which has highlighted this diversity of suburbs the lack of attention to the variety of health conditions should not come as too much of a surprise.[15] What is surprising, however, is the inattention given to the health conditions of North American central cities in an historical context.

Urban historians, for one, have, for the most part, ignored health as an important issue. Though there is an awareness of the significance of urban mortality, a survey of 'classic' urban history texts suggests relatively few have undertaken any systematic examination of the issue. The 1970s and '80s witnessed the publication of a large number of urban history texts that documented the development of the American city.[16] These texts,

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14 R. Harris and M. Mercier, 'How healthy were the suburbs?', *Journal of Urban History*, # (forthcoming).

15 R. Harris and R. Lewis, 'The geography of North American cities, 1900-1950: a new synthesis', *Journal of Urban History*, 27 (2001).

16 See, for example, A. Callow, *American Urban History: An Interpretive Reader* (New York, 1969); K. Jackson, *Crabgrass Frontier: The Suburbanisation of the United States* (Oxford, 1985); B. McKelvey, *American Urbanization: A Comparative History* (Illinois, 1973); B. McKelvey, *The City in American History* (London, 1969); B. McKelvey, *The Urbanization of America, 1860-1915* (New Jersey, 1963); R.A. Mohl and N. Betten (eds.), *Urban America in Historical Perspective* (New York, 1970); R.A. Mohl and J. Richardson (eds.), *The Urban Experience: Themes in American History* (California, 1973); E. Monkkonen, *America Becomes Urban: The Development*

which became widely influential, documented the history of municipal politics, industrial and commercial growth, social mobility, immigration, policing, planning, and in a small minority of cases even sanitation and public health. Most document the poor living and housing conditions of the immigrant slums, and generally assume that these conditions had adverse effects on health. While they were probably correct in assuming this, there is little effort to document the effect. In fact, there is little discussion about health at all. This is surprising given that the impact on health is surely one of the most important dimensions of poor housing and living conditions. Along with a number of other important achievements, gains in health, as measured by decreasing age-standardised mortality rates (such as infant and child mortality rates) or increases in life expectancy, was one of the crowning achievements of society in the urban era, and as such, should hold at least a place in the chronicle of urban history. There are, of course, exceptions to this general disregard to health as an important urban issue, but they are, to be sure, in the minority.[17]

Like contemporaries, some environmental historians have made (historical) linkages

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of American Cities and Towns, 1780-1980 (Berkeley, 1988); R. Murphy, *The American City: An Urban Geography* (New York, 1974); A.M. Schlesinger, *The Rise of the City, 1878-1898* (New York, 1933); J. Teaford, *The Twentieth Century American City* (Baltimore, 1986).

17 See, for example, D. Goldfield and B. Brownell, *Urban America: From Downtown to No Town* (Boston, 1979); D. Ward, *Cities and Immigrants: A Geography of Change in Nineteenth Century America* (New York, 1971); S.B. Warner, *The Urban Wilderness: A History of the American City* (New York, 1972); S.B. Warner, *The Private City: Philadelphia in Three Periods of its Growth* (Philadelphia, 1968).

between health and urban environmental circumstances. Yet, as Melosi recently noted, most have ignored the city, including the issue of urban health.[18] However, a few historians have recently linked the history of air, water and solid waste pollution in American cities with death rates. Melosi, in a comprehensive history of sanitation in American cities, made connections between the reduction of urban death rates from typhoid fever and the introduction of water filtration and chlorination.[19] Melosi's work implies, but not necessarily demonstrates, a direct connection between the health of populations and their urban environmental conditions, in this case water supply and treatment. In a similar way, Tarr links health outcomes with air and solid waste pollution in his study of Pittsburgh.[20] Public health historians have also tried to quantify the impacts of public health initiatives in terms of reduced mortality rates.[21] While it is difficult to do this conclusively, the

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18 M. Melosi, *Effluent America: Cities, Industry, Energy, and the Environment* (Pittsburgh, 2001), 126.

19 M. Melosi, *The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present* (Baltimore, 2000), 136-48.

20 J. Tarr, *The Search for the Ultimate Sink: Urban Pollution in Historical Perspective* (Akron, 1996); J. Tarr, 'The metabolism of the industrial city: the case of Pittsburgh', *Journal of Urban History*, 28 (2002), 513-23.

21 See, for example, J. Duffy, *The Sanitarians: A History of American Public Health* (Chicago, 1990); J. Duffy, *A History of Public Health in New York City, 1625-1866* (New York, 1968); J. Duffy, *A History of Public Health in New York City, 1866-1966* (New York, 1974); S. Galishoff, *Safeguarding the Public Health: Newark, 1895-1918* (Westport, 1975); C.R. King, *Children's Health in America: A History* (New York, 1993); J.W. Leavitt, *The Healthiest City: Milwaukee and the Politics of Health Reform* (Princeton, 1982); R.A. Meckel, *Save the Babies: American Public Health Reform and the Prevention of Infant Mortality, 1850-1929* (Baltimore, 1990); G. Rosen, *A History of Public Health* (Baltimore, 1958).

evidence for the impact of public health on improved health status is fairly strong. However, a serious limitation of the public health history literature is the inability to generalise from the initiatives of particular cities.

Given these gaps in the urban, environmental and public health history literature, our understanding of inter-urban variations in health, in an historical context, is limited. While reasonable assumptions about the health impacts of extreme levels of household crowding, population density, poor sanitary services, large agglomerations of people, and so on can be readily made, these assumptions have to remain just that, assumptions. To date, little scholarly work has inserted the 'urban' into urban health. In other words, specifically, why were mortality rates higher in North American cities than the countryside? What factors contributed to the inter-urban variability in mortality rates? What triggered the decline of mortality rates in specific places? While demographic historians have begun to chronicle the trend in mortality rates for various places, and document the variation in mortality between cities, they have, for the most part, ignored what it is that makes each city unique, or what contributes to the variability between cities.

Broadly speaking, we know that mortality rates in the pre-industrial period were moderately high, and highly volatile, due to large scale epidemics and pandemics; the most

significant of which were the waves of bubonic plague that swept through Europe and Asia beginning in the mid-fourteenth century.[22] Endemic infectious diseases such as enteritis, pneumonia, bronchitis and typhoid fever replaced pandemics of plague and smallpox as the dominant causes of death in the nineteenth century.[23] Infant mortality rates rose gradually between the late seventeenth and mid-eighteenth centuries as the population slowly became more urbanised, and then increased sharply in the early nineteenth century due to a general deterioration of the environment resulting from rapid urbanisation.[24] Although the specific timing of the secular decline in infant mortality for either Canada or the United States is not precisely known, local studies suggest that the decline occurred towards the end of the nineteenth century (or at the beginning of the twentieth century), that the timing varied from place to place, and that all locations saw significant declines after 1900.[25]

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22 M. Livi-Bacci, *A Concise History of World Population* (Malden, 1997), 49-52.

23 See, for example, H.O. Lancaster, *Expectations of Life: A Study in the Demography, Statistics, and History of World Mortality* (New York, 1990), 355; R. Porter, *The Greatest Benefit to Mankind: A Medical History of Humanity* (New York, 1997), 425-6; S. Preston and M. Haines, *Fatal Years: Child Mortality in Late Nineteenth Century America* (Princeton, 1991), 4-5; R. Schofield and D. Reher, 'The decline of mortality in Europe', in R. Schofield and D. Reher (eds.) *The Decline of Mortality in Europe* (Oxford, 1991), 6.

24 G. Alter, 'Infant and child mortality in the United States and Canada' in A. Bideau, B. Desjardins, and H.P. Brignoli (eds.) *Infant and Child Mortality in the Past* (Oxford, 1997), 92-6; P. Bairoch, *Cities and Economic Development: From the Dawn of History to the Present* (Chicago, 1988), 228-42.

25 Alter, 'Infant and child mortality', 96; Bairoch, *Cities and Economic Development*, 228-42; C.A. Corsini and P.P. Viazzo (eds.) *The Decline of Infant and Child Mortality: The European Experience, 1750-1990* (Netherlands, 1997).

Documenting the trends in national mortality rates has captured the attention of many demographic historians, but determining explanations for this dramatic improvement in mortality rates is also of great interest. Four theories have predominated.[26] Recently, however, many demographic historians have suggested that no single theory adequately explains this mortality decline. Rather a multi-causal explanation which espouses the benefits of each of public health and sanitation, improved living standards and nutritional gains, changing virulency of disease, and medical advances has received widespread support as the most plausible explanation for the mortality transition.[27] In order to determine which factors mattered most it is essential to understand the processes which lead to spatial and temporal variations in mortality rates and, even more fundamentally, we need to establish the historical-geographical patterns. Inter-urban variations in mortality rates were substantial, and so understanding this variation may help clarify the relative importance of

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26 Each theory links mortality decline with a different mechanism for change. The first espouses the benefits of scientific medicine, see, R. Porter, *The Greatest Benefit to Mankind*; the second suggests that gains in standard of living, and nutritional improvements were key, see, T. McKeown, *The Role of Medicine: Dream, Mirage or Nemesis?* (Princeton, 1979); the third, and likely most popular theory, advocates the role of public health and sanitation in mortality decline, see, for example, S. Szreter, 'The importance of social intervention in Britain's mortality decline c.1850-1914: a re-interpretation of the role of public health', *Social History of Medicine*, 1 (1988); G. Condran and E. Crimmins-Gardner, 'Public health measures and mortality in U.S. cities in the late nineteenth century', *Human Ecology*, 6 (1978); G. Condran and R. Cheney, 'Mortality trends in Philadelphia: age- and cause-specific death rates, 1870-1930', *Demography*, 19 (1982); the fourth, and final, theory suggests that the changing virulency of some of the most common and deadly diseases was responsible for a significant proportion of the mortality decline, see, R. Woods, *The Demography of Victorian England and Wales* (Cambridge, 2000).

27 The best argument for such a theory comes from, A. Hardy, *The Epidemic Streets: Infectious Disease and the Rise of Preventative Medicine, 1856-1900* (Oxford, 1993).

different causal influences. Furthermore, focussing on these inter-urban variations highlights the considerable variety of local conditions, and therefore may help historians explain why reform movements were more active, or public health initiatives were introduced earlier, in some places than in others.

Tremendous variation in mortality rates, both temporally and spatially, characterised the nineteenth century. Geographical variation in mortality occurred at several spatial scales. At the national scale, analyses of mortality trends have been most common for Europe.[28] There, two different mortality regimes have been identified, with nineteenth century levels of industrialisation and urbanisation differentiating the two.[29] Recent analyses

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28 National mortality rates exist for many European countries from the early nineteenth century, and some, such as Sweden from earlier still. In North America it is impossible to construct truly national rates until well into the twentieth century. In the United States mortality rates were tabulated for the Death Registration Area from 1900, but as noted earlier this comprised only the more highly urbanised north-east. The entire country was not included in the DRA until 1933. For more on the DRA, see, M. Haines, 'The white population of the United States, 1790-1920', in M. Haines and R. Steckel (eds.) *A Population History of North America* (Cambridge, 2000), 329. In Canada, a national system of death registrations was not implemented until the 1920s. Prior to that time, records were kept solely by provinces. In Canada's two most populous provinces, Ontario and Quebec, two entirely different registration systems were set up. Ontario established a civil registration system and Quebec maintained an ecclesiastical one that was notoriously incomplete. For more on the vital registration systems in Canada, see, G. Emery, *Facts of Life: The Social Construction of Vital Statistics, Ontario 1869-1952* (Montreal, 1993).

29 For the first regime mortality decline began at the close of the nineteenth century. Countries in this group were more highly urban and industrialised, and include England and Wales, France, Belgium, Germany and Austria. For the second regime, mortality decline began much earlier in the nineteenth century, though there was an acceleration of the pace of decline towards the end of the century. Countries in this group were much less urbanised. Sweden, Spain, and Italy characterise this second group. For documentation of the mortality trend in these European countries, see the following edited volumes, R. Schofield, D. Reher, and A. Bideau (eds.) *The Decline of Mortality in*

of mortality variations have also been conducted at the global and more localised regional scales.[30] While considerable variation existed between countries and regions, differences between urban and rural areas also existed. Bairoch noted that in nineteenth century Europe, urban infant mortality rates exceeded rural rates by between thirty and sixty percent.[31] Williams and Galley determined that mortality differentials in England and Wales were greatest between the largest cities and the rural areas. They suggest that much of the excess urban infant mortality was due to infectious diarrhoeal diseases which were eight times higher in cities than the countryside and were most harmful to infants and young children.[32] Weber too observed the urban-rural differential for England and Wales.[33]

In North America similar urban-rural differentials have been observed, particularly

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Europe (Oxford, 1991); A. Bideau, B. Desjardins, and H.P. Brignoli (eds.) *Infant and Child Mortality in the Past* (Oxford, 1997); C. Corsini and P.P. Viazzo (eds.) *The Decline of Infant and Child Mortality: The European Experience, 1750-1990* (Netherlands, 1997); also, see, N. Williams and C. Galley, 'Urban-rural differentials in infant mortality in Victorian England', *Population Studies*, 49 (1995); J. Sundin, 'Culture, class, and infant mortality during the Swedish mortality transition, 1750-1850', *Social Science History*, 19 (1995).

30 A. Cliff, P. Haggett, and M. Smallman-Raynor, *Deciphering Global Epidemics: Analytical Approaches to the Disease Records of World Cities, 1888-1912* (Cambridge, 1998); R. Woods and N. Shelton, *An Atlas of Victorian Mortality* (Liverpool, 1997).

31 Bairoch, *Cities and Economic Development*, 230.

32 Williams and Galley, 'Urban-rural differentials', 411-3.

33 Weber, *Growth of Cities*, 346-7.

for infants and children. For New England, Weber determined that urban infant and child mortality rates were more than double those of rural areas.[34] Condran and Crimmins confirmed Weber's assessment and concluded that infant and childhood mortality rates had the largest urban-rural differentials of any group because the diseases that were most likely to be affected by population concentration (diarrhoeal diseases, measles, diphtheria and croup, etc.) were also diseases of childhood.[35] In turn of the century United States, child mortality was 22 percent higher in urban places than in rural areas, though a greater difference (39 percent) was observed between rural areas and cities of greater than 25 000 people (excluding the 10 largest cities).[36]

While both rural and urban mortality rates declined, in Britain and the United States, in the latter half of the nineteenth century, the urban rates were declining much faster, such that by the 1920s the two rates had converged. This convergence has been observed and noted for both Europe and North America.[37]

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34 Weber, *Growth of Cities*, 344-6.

35 G. Condran and E. Crimmins, 'Mortality differentials between rural and urban areas of states in the northeastern United States 1890-1900', *Journal of Historical Geography*, 6 (1980), 201.

36 Preston and Haines, *Fatal Years*, 91, 97-102.

37 Bairoch, *Cities and Economic Development*, 230; Condran and Crimmins, 'Mortality differentials', 201; R. Higgs, 'Mortality in rural America, 1870-1920: estimates and conjectures', *Explorations in Economic History*, 19 (1973); Preston and Haines, *Fatal Years*; 97; Williams and Galley, 'Urban-rural differentials', 411; R. Woods, P Watterson, and J. Woodward, 'The causes of rapid infant

In general, urban rates were declining in the late nineteenth century, but variation between cities was substantial. Within Europe, Moscow, with a nineteenth century average of 350 infant deaths per 1000 births continuously had among the highest infant mortality rates. Across the globe, Adelaide's 1900 infant mortality rate of 108 was among the lowest worldwide (**Table 2.1**). In general, cities of central and eastern Europe such as Berlin, Vienna, Leningrad, and the above mentioned Moscow, had nineteenth century infant mortality rates well in excess of 250. In contrast, western European and British cities were comparatively healthy.[38] Mortality rates for North American cities tended to fall somewhere between these two extremes.[39] Of course, while generalisations such as these highlight broad patterns, they also mask the significant variations that existed. In Canada for example, cities with large French-Canadian populations such as Montreal, Quebec City, and even Ottawa were consistently among the highest worldwide, while others such as Toronto and Hamilton were more in line with those in the United States.[40] And as this paper shows,

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mortality decline in England and Wales, 1861-1921 - Part I', *Population Studies*, 42 (1988), 353-62.

38 Bairoch, *Cities and Economic Development*, 231; Lancaster, *Expectations of Life*, 307; B.R. Mitchell, *International Historical Statistics: Europe, 1750-1988* (New York, 1992), 117-120; P.M. Smith and L. Frost, 'Suburbia and infant health in late nineteenth- and early twentieth-century Adelaide', *Urban History*, 21 (1994), 259.

39 Meckel, *Save the Babies*; Alter, 'Infant and child mortality', 95-105.

40 M. McInnis, 'The population of Canada in the nineteenth century', in M Haines and R. Steckel (eds.) *A Population History of North America* (Cambridge, 2000), 405. M. McInnis, 'The demographic transition', in D. Kerr and D. Holdsworth (eds.) *Historical Atlas of Canada, Vol III:*

significant variation in mortality rates existed between cities in Ontario alone.

Demographic historians have increasingly sought to explain the variation in mortality that exists between cities. A number of factors have been linked to the variation in urban infant mortality rates, notably population size, density and crowding, as well as the social/cultural composition of the local population. In the United States, clear evidence of a strong relationship between city size and child mortality has emerged.[41] Small cities had mortality rates twenty percent higher than rural areas, while large cities (greater than 25 000 people) had mortality levels twenty percent higher still. Large cities were noticeably unhealthy as they had higher population densities, greater rates of poverty, poorer housing and environmental conditions, and lacked necessary sanitation systems. While mortality was highest in the larger cities, by 1900 the mortality levels in the very largest U.S. cities had fallen below that of the cities in the next lowest category. The largest cities appear to have been on the cutting-edge of sanitary and public health initiatives and so saw declines in mortality rates before other urban areas.[42] Similar findings have emerged elsewhere. In

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Addressing the Twentieth Century, 1891-1961 (Toronto, 1990), Plate 29; M. McInnis, 'Infant mortality in late nineteenth century Canada', in A. Bideau, B. Desjardins, and H.P. Brignoli (eds.) *Infant Mortality in the Past* (Oxford, 1997), 273-275.

41 Preston and Haines, *Fatal Years*, 97-102.

42 Preston and Haines, *Fatal Years*, 98-9, 151.

France, city size was inversely related to child survivorship. Being higher in the French urban hierarchy was correlated with decreasing rates of child survivorship.[43] For England and Wales, Woods and Shelton found that life expectancy at birth in the 1860s declined as population size increased. In fact, they suggest that babies born and living in cities of ten thousand people could expect to live 13 years longer than those living in cities of one hundred thousand.[44] There seems to have been a generally positive relationship between city size and mortality rates such that larger cities had higher infant and child mortality rates, though public health initiatives had, by the turn of the century, begun to dampen it.

Similarly, in studies of Britain, a clear relationship between mortality and not just city size, but also population density was found. In late nineteenth century England and Wales, over fifty percent of the variation in infant mortality rates between registration districts could be explained by population density alone.[45] The relationship between infant mortality and population density was found to be even stronger later in the nineteenth

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43 P. Bourdelais and M. Demonet, 'Infant mortality in French cities in the mid-nineteenth century', in C.A. Corsini and P.P Viazzo (eds.) *The Decline of Infant and Child Mortality: The European Experience, 1750-1990* (Netherlands, 1997), 107.

44 Woods and Shelton, *An Atlas of Victorian Mortality*, 147.

45 Woods, Watterson and Woodward, 'The causes of rapid infant mortality decline, Part I', 356.

century.[46] In a contemporary and substantive study of the United States, Weber also shows a clear mortality gradient as population density increases.[47] In the more densely populated cities, environmental conditions were worsened by a lack of sanitary services. A degraded urban environment became more hazardous particularly to those young children who were no longer breast-fed. They were deprived of both the natural antibodies that breast-feeding provides and more exposed to harmful pathogens found in solid foods, cows' milk and drinking water. This 'sanitary-density effect' works through a greater propensity of endemic infectious diseases to spread through drinking water supplies of dense urban neighbourhoods which use outdoor water closets and privy vaults. Similarly, airborne infections are more easily spread in crowded, and poorly ventilated dwellings.

An alternative measure of population density is crowding. While population density is normally measured as the average number of persons per unit of land, crowding is generally measured by the number of persons per room or dwelling. Intuitively, when more people are crowded into a smaller dwelling, the chance of spreading infections increases. Based on results from Baltimore, Woodbury found that the mortality rate for families living

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46 R. Woods, N. Williams, and C. Galley, 'Differential mortality patterns among infant and other young children: the experience of England and Wales in the nineteenth century', in C.A. Corsini and P.P. Viazzo (eds.) *The Decline of Infant and Child Mortality: The European Experience, 1750-1990* (Netherlands, 1997), 62-3.

47 Weber, *The Growth of Cities*, 345.

in crowded homes (more than two persons per room) was two and a half times greater than in non-crowded homes.[48] This differential between crowded and non-crowded homes was even more noticeable for specific causes of death; the mortality rate from gastro-intestinal diseases was nearly four times greater in the most crowded homes. The incidence of respiratory diseases was also greater in crowded homes. Obviously, the degree of crowding is directly related to household income, but Woodbury found that even after controlling for household income the mortality differential remained.[49] Controlling for income, the mortality rate in crowded homes was double that of the non-crowded homes. Clearly then, greater household crowding, like population density, resulted in higher infant mortality rates.

Finally, several local studies have highlighted the importance of cultural practices in determining mortality rates. Practices such as child-rearing, breast-feeding, food preparation, cleanliness and hygiene, as well as family planning, are commonly passed down through families and cultural groups. It is not surprising, therefore, that scholars have found strong regional variations in child-rearing practices, especially breast-feeding. In Germany, Kintner found that "prolonged breast-feeding was common throughout north-western Germany, aside from major cities such as Berlin, Hamburg, and Bremen. In contrast, most

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48 R.M. Woodbury, *Causal Factors in Infant Mortality: A Statistical Study Based on Investigations in Eight Cities*, (Washington, 1925), 125.

49 Woodbury, *Causal Factors*, 130.

infants were never breast-fed in south-eastern Germany."[50] More importantly, a strong inverse correlation between these regional variations in breast-feeding and infant mortality rates was identified.[51]

Variations in child-rearing and feeding practices go beyond regional differences. Distinct cultural variations have been uncovered in a variety of places. Of particular relevance are a few Canadian studies which have shown that high infant mortality rates were experienced by French-Canadians in the late nineteenth and early twentieth centuries and the authors have speculated that this was due to cultural practices that were less suited to the unsanitary urban environment. French-Canadians, at all levels of the socio-economic hierarchy, had higher rates of infant mortality in Montreal than did either the Irish-Catholic or Anglo-Protestant groups.[52] As in Germany, socio-economic factors were insufficient to explain this cultural difference. Thornton and Olson conclude that

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50 H. Kintner, 'Trends and regional differences in breastfeeding in Germany from 1871 to 1937', *Journal of Family History*, (1985), 177.

51 H. Kintner, 'The impact of breastfeeding on regional differences in infant mortality in Germany, 1910', *European Journal of Population*, 3 (1987).

52 P. Thornton and S. Olson, 'Family contexts of fertility and infant survival in nineteenth century Montreal', *Journal of Family History*, 16 (1991), 402; P. Thornton and S. Olson, 'Infant vulnerability in three cultural settings in Montreal, 1880', in A. Bideau, B. Desjardins, and H.P. Brignoli (eds.) *Infant and Child Mortality in the Past* (Oxford, 1997), 222; P. Thornton and S. Olson, 'A deadly discrimination among Montreal infants, 1860-1900', *Continuity and Change*, 16 (2001), 100-11.

> [t]he vulnerability of infants to such factors [income, environment, housing, etc] seems to depend upon culturally rooted practices. As other studies have reported, infant mortality is affected by variations in practices such as breast-feeding, age and season of weaning, care and nursing of infants, and spacing of births. All of these practices are culturally based and characterise certain ethnic groups and certain regions.[53]

Similar results were found in a local-level study of Ottawa, a predominantly English-speaking city with a large minority of French-Canadians.[54] In a regional analysis, the largely French-speaking province of Quebec had an IMR two thirds higher than English-speaking Ontario. More startling, however, the counties in Quebec which had large English-speaking populations had mortality rates similar to those in Ontario, while the largely French-speaking counties in Ontario were more comparable with counties in Quebec.[55]

At the other end of the mortality spectrum from the French-Canadians is the Jewish population. Scholars have pointed out the comparatively healthy practices of the Jews, including longer periods of breast-feeding and a strict adherence to sanitary laws based on

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53 Thornton and Olson, 'Infant vulnerability', 237.

54 M. Mercier and C. Boone, 'Infant mortality in Ottawa, Canada, 1901: Assessing cultural, economic and environmental factors', *Journal of Historical Geography*, 28 (2002).

55 McInnis, 'Infant mortality', 265.

religious beliefs, and the possibility that these practices contributed to lower mortality.[56] Indeed, the mortality rates of Jews, particularly their infants and children, were considerably lower than the non-Jews amongst whom they lived. In an analysis of mortality rates in 1890 New York, Weber found that despite being among the poorest, most densely settled, and poorly housed New Yorkers, the Russian and Polish Jews had mortality rates among the lowest in the city.[57] It has been shown that the Jewish mothers' longer periods of breast-feeding were important to their comparatively low mortality rates in the United States, but were insufficient alone to explain this mortality advantage.[58] Similar conclusions were made by Marks in a study of Jews in east London.[59]

Mortality differentials between other social groups have also been observed for nineteenth century America. Recent immigrant families had higher child mortality rates than did those families whose parents were native-born. Of the immigrant groups, families from the United Kingdom and Germany had poorer child survival rates than did those from

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56 G. Condran and E. Kramarow, 'Child mortality among Jewish immigrants to the United States', *Journal of Interdisciplinary History*, 22 (1991); L. Marks, *Model Mothers: Jewish Mothers and Maternity Provision in East London, 1870-1939* (Oxford, 1994); Woodbury, *Causal Factors.*

57 Weber, *The Growth of Cities*, 350.

58 Condran and Kramarow, 'Child mortality', 252.

59 Marks, *Model Mothers*, 43-91.

Scandinavia.[60] The child mortality rate for African-Americans was also considerably higher than the national average. Preston and Haines argue that the "[d]ifferent customs of child-raising are probably reflected in ethnic differences in child mortality" and central to these ethnic differences is the role of breast-feeding.[61] Furthermore, they claim that "breast-feeding customs differed ... and were likely responsible in good measure for the exceptionally low mortality of babies born to Jewish mothers and the exceptionally high mortality of those born to French-Canadians."[62] Aside from breast-feeding, other child-rearing practices have been shown to have important impacts on infant health in other contexts as well.[63]

Emerging from this literature then are a number of key points. Urban-rural differentials, and significant inter-urban variations, in infant mortality rates have been observed in Europe as well as North America. Efforts to explain these variations have

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60 Preston and Haines, *Fatal Years*.

61 Preston and Haines, *Fatal Years*, 42.

62 Preston and Haines, *Fatal Years*, 42.

63 J. Knodel, 'Child mortality and reproductive behaviour in German village populations in the past: a micro-level analysis of the replacement effect', *Population Studies*, 36 (1982); J. Knodel and A. Hermalin, 'Effects of birth rank, maternal age, birth interval, and sibship size on infant and child mortality: evidence from 18th and 19th century reproductive histories', *American Journal of Public Health*, 74 (1984); B. Moring, 'Motherhood, milk and money: infant mortality in pre-industrial Finland', *Social History of Medicine*, 11 (1998); Sundin, 'Culture, class and infant mortality'.

centred on ecological characteristics of cities such as population size, urban density, and crowding. Local case studies have further highlighted the importance of cultural differences. It is with these points in mind that the inter-urban variations in infant mortality in Ontario are explored.

2.3 - THE ONTARIO URBAN CONTEXT

At the turn of the twentieth century, Ontario contained urban centres of varying sizes, but the majority were quite small. According to the Canadian Census, places are labelled urban when their population exceeds five thousand. On this criterion, there were 24 urban places in 1881, rising to 35 by 1911. The median population size was 7741 in 1881, rising to 10 770 in 1911, and 17 369 in 1941. Growth in both number and size of urban areas indicates that Ontario was urbanising at a rapid rate during this period. In 1881, a sixth of Ontario residents lived in one of these urban places. By 1911, the urban share of population had reached a third, and by 1941 nearly a half.

Ontario's urban system was dominated by one city. With a population of 85 000 in 1881, 375 000 in 1911, and 665 000 in 1941, Toronto was home to about forty percent of Ontario's urban population and, as much as twenty percent of the entire provincial

population between 1901-1941. The second-largest city in Canada (behind Montreal), Toronto was more than four times larger than any other city in the province (Hamilton or Ottawa). However, despite this relative dominance in the Ontario urban system, in this period Toronto never ranked higher than eleventh (in 1920/21) among all North American cities.[64] Within Ontario, significant variation exists between cities in terms of size, density, crowding, economic and political function, and cultural composition.

Throughout this study, figures for urban places include only the city/town proper, and do not include unincorporated suburbs. This distinction matters most in the larger centres such as Toronto, Ottawa, Hamilton and Windsor, all of which had substantial suburban and satellite neighbours, and it becomes more significant in the later years of the study. Beginning in the early 1910s, many cities stopped annexing suburban territory, mainly due to the financial burden of providing services to these more sparsely populated areas. However, as development in these larger cities was already pushing towards the urban boundary, much of the growth in the 1910s and beyond was in these suburban communities rather than in the city proper. For example, the share of the metropolitan population of Toronto actually in the City was 95 percent in 1901, but declined to less than 75 percent by

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64 R. Harris, *Unplanned Suburbs: Toronto's American Tragedy, 1900-1950* (Baltimore, 1996).

1941.[65] While the population of the City of Toronto grew by a factor of three between 1901-1941, the population in the neighbouring suburbs grew twenty-two times over in the same period.[66]

2.4 - METHODS AND SOURCES OF DATA

For the province's 35 cities, birth and death data were extracted at five year intervals from the published annual Register of Births, Marriages, and Deaths for the period 1881-1941 (see **Figure 2.1**).[67] Registration data were supplemented with information on the physical size of the city (in acres), measures of internal household crowding, and the ethnic composition of each city and county from the decennial Census. Due to the extensive growth of the province over this period, particularly in the north, some rural counties and small cities do not appear in every year. The overall urban mortality rate was calculated from the aggregation of the births and deaths for the cities and towns in the province, while

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65 Harris, *Unplanned Suburbs*, 40-5.

66 Harris, *Unplanned Suburbs*, 42-3.

67 Registrar General (Ontario), *Annual Report*. In a couple of cases the interval was one year more or less than this five year period due to problems in the data reported in the published Register. For instance, in 1896 the Register did not publish mortality figures for a sufficient number of cities, so 1897 was chosen. Similarly, 1905 was selected over 1906 because figures of the number of infant deaths were not published in that year.

the rural rate was determined by aggregating the mortality rate for each county minus the urban areas enclosed within them.[68]

As the published birth and death registrations are the primary sources of data, their accuracy and reliability are worth noting. Emery found that the birth and death registrations in Ontario were generally reliable, but that prior to 1896 there were some problems.[69] The first Registration Act (1869) in Ontario made it compulsory for vital events to be registered, but this was largely ignored. In 1870, the provincial Registrar General estimated that registrations of births and deaths were only 33 and 20 percent complete respectively.[70] A revised Act (1875) improved the system such that, by 1876 the number of registered deaths had doubled and births increased by half. By 1880, provincial death registrations were estimated to be 60 percent complete, and births 70 percent.[71] Ontario's third attempt at the Registration Act (1896) assured almost complete registration of vital events. With each Act the government changed the way births and deaths were registered. For the most part these

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68 Births and deaths were collected for each urban area, and summed, to create a mortality rate for the entire urban population. For each county, the births and deaths occurring in urban places were subtracted from the county total, and the remainder was used to calculate the rural mortality rate. In this way, rates were standardised to allow for comparisons across time and space.

69 Emery, *Facts of Life*.

70 Emery, *Facts of Life*, 32.

71 Emery, *Facts of Life*, 34.

changes focussed on the method and amount of payment made to local registrars, the penalties imposed on heads of households or attending professionals (doctors, midwives, clergymen, etc.) for not registering a vital event, and the requirement that clergymen must see a death certificate before a burial could take place.[72] By the turn of the century essentially all deaths were registered. The same rate of success for births, however, was not achieved until the 1920s.[73]

Aggregate rates of registration completeness disguise local variations. Coverage was always more complete in urban than in rural areas. Emery suggests that death registrations in cities were essentially complete by the early 1880s, but not in rural areas until after 1900.[74] Even so, some cities, including Ottawa, were still sometimes unable to submit complete returns in the 1890s. The importance of monitoring the spread of infectious diseases, prompted public health officials to be much more vigilant at recording deaths than births. As a result, since the calculation of infant mortality rates depends on both the number of births and deaths, the infant mortality rate is likely somewhat overstated,

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72 Emery, *Facts of Life*, 31-42.

73 A re-interpretation of the success rate of Ontario's nineteenth century registration system suggests that the first Registrar Generals may have been overly pessimistic in their assessment. See, Emery, *Facts of Life*, 36, 41-2.

74 Emery, *Facts of Life*, 31-2.

especially in the earlier years of this study.

2.5 - MORTALITY PATTERNS AND TRENDS IN ONTARIO

Ontario's infant mortality rate began an uninterrupted decline in about 1905 (**Figure 2**). Its timing and pace is consistent with trends elsewhere, if somewhat delayed. The data show that Ontario's infant mortality trend resembles, quite closely, that of England and Wales and the other highly urbanised countries of nineteenth century Europe, including France, Belgium, Germany and Austria.[75] Like Ontario, these countries generally experienced infant mortality decline in the late nineteenth century or the first decade of the twentieth.

The mortality decline was most rapid in the cities. In Ontario in the 1880s, the urban IMR is more than double the rural rate. This urban-rural differential, however, declines in each year so that by the 1920s there was effectively no difference (**Figure 2.2**). A similar convergence of the urban and rural rates has been observed elsewhere in North

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75 As noted previously, national rates for Canada (as a whole) and the United States are not known. For the trends of the European countries see, Schofield, Reher, and Bideau (eds.) *The Decline of Mortality in Europe*; Bideau, Desjardins, and Brignoli (eds.) *Infant and Child Mortality*; Corsini and Viazzo (eds.) *The Decline of Infant and Child Mortality*; Williams and Galley, 'Urban-rural differentials'.

America and Europe, and this convergence occurred at roughly the same point in time.[76] While the urban rates declined, and rural rates remained relatively static, the provincial mortality rate held fairly constant until approximately 1905. The reason was the continued and increased urbanisation of the province.[77] Almost all of the population growth in Ontario occurred in the urban areas after 1881. The proportion of the population living in urban areas increased from 15 percent to nearly 50 percent by 1941. An increasing proportion of the population was living in the comparatively unhealthy urban areas. A persisting urban-rural differential, and the continued urbanisation of the province, delayed the decline in the overall provincial rate by at least a couple of decades.

The narrowing of this urban-rural mortality differential reflected the more rapid decline in urban rates. With the exception of a dip around 1890 (which affected both urban and rural areas) the rural infant mortality rate in Ontario changed very little between 1880 and 1920.[78] In contrast, the infant mortality rate in Ontario's urban areas declined about 60

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76 Bairoch, *Cities and Economic Development*, 230; Condran and Crimmins, 'Mortality differentials', 201; Higgs, 'Mortality in rural America'; Preston and Haines, *Fatal Years*; 97; Williams and Galley, 'Urban-rural differentials', 411; Woods, Watterson, and Woodward, 'The causes of rapid infant mortality decline, Part I', 353-62.

77 For the connection between persistently high mortality rates and rapid urbanisation, see, R. Woods, 'The effects of population redistribution on the level of mortality in nineteenth-century England and Wales', *Journal of Economic History*, 45 (1985).

78 This dip in the early 1890s is explained by province-wide problems in the registration of births and deaths, and in the calculation of population levels in many communities. These problems were

percent over the same period. The most likely explanation for this decline lies with public health. Many important initiatives were undertaken. These included the construction of sewer and water-supply systems, the introduction of birth registration and follow-up home visits by public health nurses, public education initiatives focussing on hygiene, and maternal and child welfare, and the enforcement of housing regulations. This was especially true of the largest cities, Toronto, Ottawa and Hamilton.

Although the trend in infant mortality rates was broadly similar in all Ontario cities, there was notable variation as well, particularly for the years prior to 1915 (**Figure 2.3**). The variation between the healthiest city in the province (Woodstock) and the unhealthiest (Ottawa and Cornwall) was greatest in the 1890s and by 1915 had converged to a range of approximately 50 infant deaths per 1000 births. Woodstock, a fairly small (population between 5-10 000) agricultural marketplace had an IMR that was both comparable in trend and magnitude to the rural parts of the province. Cornwall, a comparably sized community (between 5-15 000) had an infant mortality rate, until 1900, that was two and a half times higher and that was exceeded only by Ottawa's. Hamilton and Ottawa, the second and third largest cities in the province respectively, also provide a unique contrast. Hamilton, the

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more pronounced in urban communities, but affected both urban and rural areas alike. The Registrar General, in his Annual Report in 1891, commented on this problem, and suggested that mortality rates for this period should be assessed cautiously (Ontario - Registrar General, *Annual Report*, 1891).

most industrial city of the province, had an infant mortality rate that was, in every year, below the urban average. This mortality advantage experienced by Hamiltonians ranged between five and thirty percent, and actually became larger from 1911 onwards. Ottawa, on the other hand, was consistently the unhealthiest city, large or small, in the province. On average, Ottawa's infant mortality rate was sixty percent higher than the average of all other urban places, and in fact prior to the late 1910s was often more than eighty percent higher. Clearly, a complex pattern of infant mortality existed in Ontario at this time, and further exploration of the underlying causes of such variation is warranted. Certainly, while city size, urban density, crowding and cultural composition of communities may explain this complex pattern, it is possible that the unique conditions of the individual cities and variations in the implementation of public health initiatives may be an important factor as well.

A systematic history of public health in Ontario has not yet been written, but local histories of specific cities reveal some important trends.[79] In terms of sanitation, Toronto was among the first to develop a comprehensive sewer and water supply system. Although storm sewers and a water supply system had been introduced in Toronto, like most North American cities, in the nineteenth century, sewage treatment, water filtration and

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79 The story of public health has been left untold in most local histories of Ontario's small cities and towns.

chlorination were not introduced until the early twentieth century.[80] In fact, Toronto was among the first cities anywhere to disinfect water through chlorination.[81] Toronto's system was up and running by the early 1910s, and Hamilton's shortly thereafter, delayed, like most municipal projects by social-class based political squabbles.[82] Ottawa, a notoriously unhealthy city as measured by infant mortality rates, was slow to introduce a safe water supply. In the context of Ottawa, the delay was a result of political conflicts between the Anglophone and Francophone populations and their political representatives. Almost a full decade after two successive deadly typhoid epidemics in 1911-12 Ottawa unveiled a new water supply that was comparatively clean.[83] Another important aspect of early public health were the milk depots, and later, well-baby clinics and home visits. Safe milk was first distributed by public health authorities around 1910 in each of Toronto, Ottawa, Hamilton and London. When legislation was later introduced to regulate the supply of milk the function of these depots changed to outlets of health education and basic health clinics. First

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80 For Toronto public health, see, for example, C. Brace, 'Public works in the Canadian city: the provision of sewers in Toronto, 1870-1913', *Urban History Review*, 23 (1995); J.M.S. Careless, *Toronto to 1918: An Illustrated History* (Toronto, 1984); H. MacDougall, *Activists and Advocates: Toronto's Health Department, 1883-1983* (Toronto, 1990); M. Piva, *The Condition of the Working Class in Toronto, 1900-1921* (Ottawa, 1979).

81 MacDougall, *Activists and Advocates*, 87-90.

82 For public health developments in Hamilton, see, R. Gagan, 'Mortality patterns and public health in Hamilton, Canada, 1900-1914', *Urban History Review*, 27 (1989); J. Weaver, *Hamilton: An Illustrated History* (Toronto, 1982).

83 J. Taylor, *Ottawa: An Illustrated History* (Toronto, 1986), 156-60.

appearing in the immediate pre-War years, these child welfare clinics, as they became known, played a key role in improving urban health conditions. By the mid-1920s most urban centres in Ontario had some system of clinics and home visits in place.[84]

2.6 - EXPLAINING VARIATIONS IN MORTALITY BETWEEN CITIES

In many respects it is misleading to talk about a single 'urban' rate since mortality varies widely from place to place. Researchers have suggested several reasons why such local variations were common. The most obvious reason was city size. Although mortality rates in the United States generally increased with city size, this was not generally the case in Ontario (see **Table 2.2**). The scatter-plot, and regression line, for the relationship between infant mortality and population size (logarithmic transformation) for 1886 is presented in **Figure 2.4**. Despite the statistical significance of the relationship in 1886, the comparatively poor fit of the regression line is apparent by the numerous outliers, particularly among the small and medium sized places. The reason for this generally weak relationship between city size and infant mortality rates may be that the province contained only one city that was large by international standards. It is, arguably, in the larger places that size and density

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84 C.R. Comacchio, *'Nations Are Built of Babies': Saving Ontario's Mothers and Children, 1900-1940* (Montreal, 1993); C.R. Comacchio, 'The infant soldier: early child welfare efforts in Ontario', in V. Fildes, L. Marks, and H. Marland (eds.) *Women and Children First: International Maternal and Infant Welfare, 1870-1945* (New York, 1992).

become especially important to mortality and ill-health. For example, in the United States, Preston and Haines found that the child mortality rate for cities with populations between 1000 and 25 000 were not all that dissimilar from rural areas, although they were slightly higher.[85] In this period, cities of less than twenty thousand people were probably too small to have the sorts of urban problems with living conditions that would lead to exceptionally high mortality rates. This is confirmed in Ontario where the predominance of small urban places (30 of the 35 cities had populations less than 20 000 in 1911, and only 3 cities had populations over 50 000) may have prevented this relationship between city size and mortality from emerging.

Where city size mattered it was often because of the association between size and urban density. In England and Wales, between thirty and fifty percent of the mortality variation in the 1800s has been explained by population density alone.[86] At first the same relationship was apparent in Ontario (see **Table 2.2**). In 1901, for example, density accounted for thirty percent of the local variation in mortality rates (**Figure 2.5**). The importance of population density soon declined, however, and by 1911 was insignificant. This trend, roughly coincides with the disappearance of the urban-rural differential. There

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85 Preston and Haines, *Fatal Years*, 100.

86 Woods, Watterson and Woodward, 'The causes of rapid infant mortality decline, Part I', 356; Woods, Williams, and Galley, 'Differential mortality patterns', 62-3.

are probably two reasons why density mattered less over time. First, the negative effects of population density for infants can largely be mitigated through breast-feeding. Infants, the majority of whom are breast-fed for at least part of the first year, are spared from many of the density related illnesses via the natural protection provided by breast-milk and limited exposure to food- and water-borne pathogens. Young children, however, once weaned from the breast, become substantially more vulnerable to infectious diseases which can spread through dense and crowded environments. Although rates of breast-feeding in Ontario are not known, it is likely that the proportion of infants being breast-fed in 1901 was less than in 1931.[87] Extensive public education programs in the early decades of the twentieth century by public health departments in Ontario, as throughout North America, extolled the virtues of breast-feeding.[88] At the same time, legislation regulating the quality of Ontario's milk supply was introduced, and new forms of infant formula and bottles were launched.[89]

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87 The history of breast feeding is incomplete at best. While rates of breast feeding in Ontario are not known, some clues can be inferred from elsewhere. We now believe that differentials in breast feeding rates exist by social class and cultural background. The poor, working-class and immigrant groups all breast fed their children more often, and for longer duration than either native born or middle- and upper-class mothers. See, V. Fildes, *Breasts, Bottles and Babies: A History of Infant Feeding* (Edinburgh, 1986); V. Fildes, 'Infant feeding practices and infant mortality in England, 1900-1919', *Continuity and Change*, 13 (1998); J. Golden, *A Social History of Wet Nursing in America: From Breast to Bottle* (Cambridge, 1996); Woodbury, *Causal Factors*.

88 MacMurchy, *Third Special Report*.

89 The milk supply in Toronto, and other Ontario cities was never clean, and in the early 1900s the quality worsened. As much as 40% of milk samples tested in 1909 were found to be contaminated. Provincial legislation in 1911 gave local health authorities the power to inspect and discard milk believed to be of poor quality. In 1914, all milk entering Toronto was required to be pasteurised. See, MacDougall, *Activists and Advocates*; Piva, *The Condition of the Working Class*.

Perhaps the impact of these initiatives were felt more strongly, and earlier, than previously thought.

A more likely explanation for this declining relationship is the growing role of other public health initiatives. Following the turn of the century many cities, again most commonly the largest and most densely populated ones, began aggressive campaigns to improve the urban environment by upgrading the sanitation infrastructure, and introducing housing regulations. These initiatives would have contributed to a reduced incidence of diarrhoeal and other infectious diseases, and thereby mitigated the effects of population density. Begun after the turn of the century, these initiatives ameliorated the problems of city living such that by the 1920s and '30s there was little observable connection between population density and mortality in Ontario.[90]

Although, for a time, urban density did affect population health, previous research has indicated that what usually mattered most was crowding at a smaller scale, within the

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90 A further plausible explanation is that this result may simply be a statistical artefact. In the early twentieth century many Ontario communities annexed suburban territory. Annexation brought sparsely populated suburban land into the boundaries of the city, effectively "diluting" the city's population density. For example, Toronto annexed several suburban communities between 1909 and 1912, doubling the physical size of the city while adding only marginally to its population (Harris 1996, 40). Despite the annexations, however, Toronto's population density actually increased from 19 persons per acre in 1901 to 35 per acre in 1911. The trend was similar across the province. The average population density for all urban places in Ontario was 6 persons per acre in 1901 and by 1911 it had risen to almost 8.

home. Internal crowding is often measured by the average number of persons per room. For Ontario, the only available measure is the average number of persons per dwelling.[91] Over the study period, in Ontario the average level of crowding declined from a high of 5.1 persons per dwelling in 1891 and 1901 to a low of 4 per dwelling in 1941. The variation among cities also narrowed. In 1901 the city of London averaged 7.5 persons per dwelling while Brockville only averaged 2.7. By 1921 the range between the most and least crowded cities had narrowed to 1.5.

High levels of crowding were, not surprisingly, apparent in many of the large cities in the province, particularly in the earlier part of the study period. Crowding within the home was a common problem in the late nineteenth century, generally in the largest cities.[92] In Ontario, however, the most crowded conditions were to be found either in the less urbanised, northern reaches of the province and/or in centres that contained a high

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91 While internal crowding is best measured by persons per room, the use of persons per dwelling is a suitable substitute. While this measure may be suitable, like most aggregate statistics it is susceptible to distortion. Some communities may have a disproportionate number of large rooming houses (which would inflate the persons per dwelling measure) in which the living conditions may not be all that crowded.

92 At the ecological level however, the relationship between city size (population) and the average level of crowding for homes within a city is not that strong. Correlation coefficients between the two variables ranged from a high of 0.47 in 1901 to 0.18 in 1941 (average = 0.29). A much stronger (positive) relationship was found between population size and density; a high of 0.82 in 1911 (average = 0.75). In the United States, crowding and density were also not that strongly associated, see, E. Crimmins and G. Condran, 'Mortality variation in U.S. cities in 1900', *Social Science History*, 7 (1983).

proportion of French-Canadians. Northern cities such as Sault Ste. Marie, North Bay, Port Arthur, Fort William and Kenora consistently had higher than average levels of crowding despite relatively small populations. The rapid expansion of the northern frontier in the early part of the century contributed to a shortage of housing, which resulted in higher than expected levels of crowding.

At the other end of the spectrum, the cities and towns of the largely rural and agricultural southwest of the province including Woodstock, Chatham, Sarnia, St. Thomas, Stratford and London (except for the earliest years), generally had the lowest levels of crowding. The relative absence of industrial activity, coupled with slower and steadier urban growth, were surely important in this regard. A similar pattern was seen in the mid-western United States in the nineteenth century.[93]

Although the average incidence of this measure of crowding did vary a good deal, especially in the early years, it had little impact on variations in mortality at the inter-urban scale. In 1911, 22 percent of the variation in infant mortality rates is explained by crowding. In other years, crowding explained, on average, only 7.5 percent of the mortality variation (see **Table 2.2**). How could this be? The usual mechanism through which crowding is

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93 Frost, *New Urban Frontier*; D. Meinig, *The Shaping of America - A Geographical Perspective on 500 Years of History: Volume II, Continental America, 1800-1867*, (New Haven, 1993), 352-74.

understood to influence mortality is that large numbers of people living in close proximity spread both epidemic and endemic infectious diseases. In Ontario's northern communities, housing conditions were crowded but urban populations were small and the population base may have been too low to support endemic infectious diseases. In Ontario cities, then, the effects of crowding did not reinforce the influence of population size and density, so that none of these factors played a major role in determining inter-urban variations in mortality. Another explanation centres on the ecological nature of the crowding data. Taking an average level of crowding for an entire city masks variations within that city. Previous studies that have found strong relationships between mortality and crowding have been undertaken at the local level where crowded neighbourhoods are contrasted with more spacious ones.

If ecological factors had only a limited and declining influence, it is possible that cultural considerations were more important. Recent case studies have shown wide differences in mortality rates between English and French-Canadians in Montreal, Ottawa, and central Canada as a whole.[94] Such differences could account for inter-urban differences, since the proportion of French-Canadians varied widely, from a low of one or two percent

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94 Thornton and Olson, 'A deadly discrimination'; Mercier and Boone, 'Infant mortality in Ottawa'; M. McInnis, 'Canada's population in the twentieth century', in M. Haines and R. Steckel (eds.) *A Population History of North America* (Cambridge, 2000).

in Toronto, Hamilton, and other central Ontario communities to a high of 44% in Cornwall in 1931. The province's urban population as a whole was only five percent French-Canadian in the early part of the twentieth century. Some of the French-Canadian communities were in the more crowded towns of Northern Ontario, but not all. Eastern cities such as Cornwall, Ottawa and Pembroke, as well as a few of the northern cities, many of which bordered with or were close to the border with Quebec, had both a high proportion of French-Canadian residents and above average levels of crowding. High fertility rates among French-Canadians, coupled with comparatively low incomes for this group is the most likely explanation.[95] In general, the proportion of the urban population that was French-Canadian explained about a third of the inter-urban variation in infant mortality rates (**Table 2.2, Figure 2.6**).[96]

The theoretical basis for this relationship between cultural groups and mortality is now relatively well established. The literature has provided ample evidence of both the positive relationship between French-Canadian populations and infant mortality, and the inverse relationship between Jewish populations and mortality. The significant factor here is likely not genetic; rather it is cultural. As we have seen, the cultural practices of

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95 McInnis, 'The demographic transition'.

96 Similar findings emerged in the rural parts of the province too; the higher the proportion of the rural population that was French-Canadian, the higher the county's IMR.

individual ethnic and cultural groups can have significant impacts on their overall health status. Similar analyses between infant mortality and other ethnic and cultural groups in Ontario in this period failed to uncover any significant associations.[97]

The association between IMR and French-Canadians is, in most years, statistically significant, and larger than that of the ecological variables. Disconcertingly, however, it fluctuates quite widely and with no secular trend.[98] I suggest that this variation may be due to the interaction between cultural practices and local climatic conditions. First, it is clear from the literature that household and child-rearing practices vary between families, and that these variations have clear cultural dimensions. The examples of French-Canadians and Jews highlight this point. Secondly, local climatic conditions, in particular the average summer temperature and amount of annual precipitation varied from year to year. In any given year average summer temperatures could vary by more than three degrees (Celsius), and annual precipitation could vary by thirty percent in either direction. In general, some conditions, such as when summers were particularly hot and dry, were more conducive to

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97 The presence of a Jewish population did not provide any measurable health benefits to urban communities via reduced infant mortality. This is not surprising since it was not until the 1920s that Jews accounted for more than five percent of the population in any one city (Toronto).

98 The relationship between infant mortality and a city's French-Canadian population could only be calculated in the decennial Census years.

the development of unhealthy environmental conditions.[99] In particular, low levels of precipitation led to reduced supplies of urban drinking water and led to a greater proportion of that water being polluted. This, in turn, contributed to a greater risk and incidence of infectious disease.

In theory then, it is the combination of these two factors which may explain the varying relationship between IMR and the proportion of the population that is French-Canadian. In poor climatic conditions, the sanitary environment deteriorates and so, the unhealthy practices of the French-Canadians become more important because their infants become more susceptible to disease and death. On the other hand, when climatic conditions are better, and ample quantities of clean and safe drinking water are available, then these potentially harmful practices are less problematic. Regrettably, the limited number of years of analysis (in only six years was I able to assess the importance of this cultural factor) precludes a statistical analysis to test this hypothesis.

In the context of Ontario the cultural composition of a community (especially the proportion of the population that is French-Canadian) appears to have an important impact on the mortality patterns. Given the concentration of French-Canadians in a relatively few

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99 G. Mooney, 'Did London pass the sanitary test? Seasonal infant mortality in London, 1870-1914', *Journal of Historical Geography*, 20 (1994), 164-5.

specific communities (Ottawa, Cornwall, Pembroke, North Bay and Windsor) what effect does controlling for this factor have? It seems, once the cultural component is controlled for (through the elimination of these cities from the analysis), there is no significant relationship between mortality and any of the other three measures of urban life (population size, population density, and crowding) in any of the five years for which such calculations could be made.[100] This further reinforces the conclusions already made, that the cultural composition of a community is of greatest importance in explaining the spatial distribution of infant mortality in Ontario.

2.7 - SUMMARY AND CONCLUDING REMARKS

This study shows that between 1881-1941 Ontario's IMR declined at roughly the same time and rate as other places in Europe and North America. While the overall infant mortality rate in Ontario began to decline around 1905, there was considerable variation in the pace and timing of the decline across the province. The most notable difference exists between urban and rural areas. While rural infant mortality rates remained stationary through to at least the 1910s, the urban rates were declining from as early as the 1880s, but

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100 The relationship between urban infant mortality rates and population size (and logarithmic transformation of population size), density and crowding could only be calculated for five decennial Census years because of limitations in data in the other years. In all but one model (crowding in 1911; $r^2 = 0.11$) the relationship was statistically insignificant.

had comparatively further to fall. By 1920 this urban-rural differential had all but disappeared, likely because public health initiatives in cities such as, water filtration and chlorination, sewage treatment, and housing regulations had finally taken effect.

Among the urban areas of the province there was also considerable variation. Based on findings elsewhere, it was expected that much of the mortality variation among urban areas could be explained by city size. There is no indication that this relationship existed in Ontario. I suggest that the reason for the absence of such a relationship is due to the lack of a sufficient number of large cities, by international standards, in the province's urban system. In other words, this may be a spurious non-relationship driven by a lack of statistical power in the model. Similarly, there was little evidence of the expected relationship between infant mortality and population density. Crowding, to a degree, had a more important impact on inter-urban variations in infant mortality rates, though the strength of the relationship was inconsistent between time periods. Analyses of the relationship between the proportion of a community's population that was French-Canadian and the community's infant mortality rate revealed the most intriguing and consistent results. Supporting the findings of other Canadian researchers, as well as an emerging international literature on the importance of cultural factors to mortality, this paper confirms that cultural differences, most likely the practices of the French-Canadians, coupled with the insanitary environment

of turn of the century Canadian cities, made for a deadly combination.

By documenting the trend of infant mortality rates in Ontario, and tackling some of the potential explanatory factors, this paper has begun to highlight some of the important issues that remain to be understood in the context of North American mortality. In particular, this paper suggests that the interactive effects of cultural differences and environmental conditions, and the role of cultural practices in determining infant mortality rates needs to be better understood. While this study found a strong relationship between infant mortality and the distribution of French-Canadians within a largely Anglo population, little association between mortality and any other ethno-religious group was uncovered. Therefore, research in this area should focus on whether this relationship exists for non-French-Canadian minority groups in specific Ontario urban places by employing a micro-level analysis.[101] Finally, although it is apparent that a community's cultural composition had an important effect on the infant mortality rate, and that other characteristics of its urbanity such as size, density and crowding were less significant, a fair portion of the mortality variation within the province remains to be 'explained'. One potentially fruitful avenue for inquiry here is the level of investment in, and differing chronology of, public

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101 Two, as yet, unpublished manuscripts by the present author address the social geography and determinants of infant and child mortality in Toronto, 1901. See, M. Mercier, 'The social geography of infant and child mortality, Toronto, 1901' and 'M. Mercier, 'The determinants of infant and child mortality in Toronto, 1901' (McMaster University, 2003).

health, and especially sanitation, by individual cities. Those cities that we may have expected to have had high mortality rates, such as Toronto and Hamilton, may have effectively negated the impact of their size, density and crowding through such investments, while others such as Ottawa may have exacerbated their problems through the delayed implementation of public health. Local level urban studies, that can assess the contributions of public health initiatives to mortality decline will help address these important issues.

Table 2.1 - Infant Mortality Rates in Select Cities, 1880-1940

	1880	1890	1900	1910	1920	1930	1940
Moscow	351	350	356	298	146	- - -	- - -
Ottawa	***385***	***285***	***292***	***268***	***139***	***98***	***49***
Montreal	- - -	***285***	- - -	- - -	***158***	***114***	***58***
Quebec City	- - -	***275***	- - -	- - -	***163***	***149***	***95***
Antwerp	- - -	- - -	210	165	98	73	61
Berlin	291	243	208	151	135	73	58
Leningrad	303	232	208	230	149	- - -	- - -
New York	250	223	183	143	71	58	37
Vienna	189	216	179	157	146	79	62
Toronto	***209***	***199***	***167***	***151***	***91***	***70***	***35***
Copenhagen	220	184	160	101	67	60	38
Birmingham	163	180	178	138	82	61	61
London	152	155	144	109	80	59	50
Hamilton	***236***	***155***	***152***	***119***	***78***	***59***	***34***
Rome	179	150	131	133	83	81	- - -
Sydney	174	139	111	75	62	50	38
Paris	172	138	111	107	95	99	66
Adelaide	- - -	128	108	77	74	55	27

Notes: Cities are ranked, in descending order, by the infant mortality rate in 1890. In some cases the mortality rate indicated here is for one or two years before or after the date indicated.

Sources: Bairoch, *Cities and Economic Development*, 231; McInnis, 'The demographic transition', Plate 29; McInnis, 'Infant mortality', 273-275; Meckel, *Save the Babies*; Smith and Frost, 'Suburbia and infant death', 259; Ontario - Registrar General, *Annual Report of Births, Marriages and Deaths*, 1880-1941.

Table 2.2 - Bivariate Regression Results for Ontario Infant Mortality and Five Urban Variables, 1881-1941: Coefficients of Determination (r^2)

	Population	Population (log)	Density	Crowding	French-Canadian Population
1881	[0.08]	**0.20**	- - -	- - -	**0.37**
1886	**0.21**	**0.37**	- - -	- - -	- - -
1891	[0.02]	[0.07]	- - -	[0.01]	N/A
1897	[0.05]	[0.08]	- - -	- - -	- - -
1901	[0.08]	**0.14**	**0.31**	[0.07]	**0.27**
1905	[0.06]	[0.06]	- - -	- - -	- - -
1911	[0.02]	[0.02]	[0.06]	**0.22**	**0.10**
1916	[0.00]	[0.00]	- - -	- - -	- - -
1921	[0.00]	[0.02]	[0.02]	[0.04]	[0.01]
1926	[0.01]	[0.05]	- - -	- - -	- - -
1931	[0.00]	[0.00]	[0.03]	**0.10**	**0.33**
1936	[0.00]	[0.00]	- - -	- - -	- - -
1941	[0.02]	[0.02]	[0.01]	**0.15**	**0.13**

Notes: Values in parentheses are **not** significant at the 95% confidence level.

Figure 2.1 - Urban Ontario Reference Map (c.1880-1940)

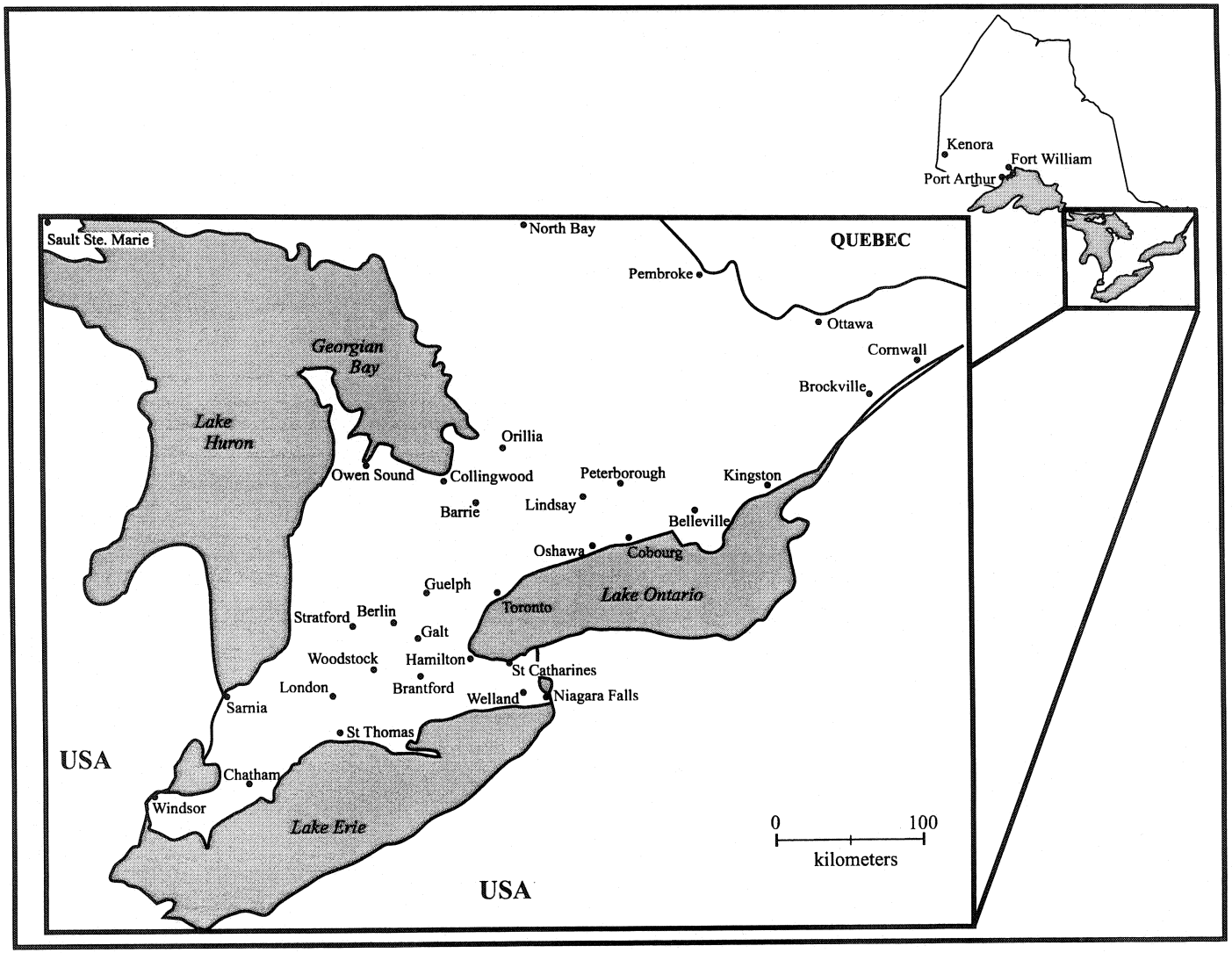
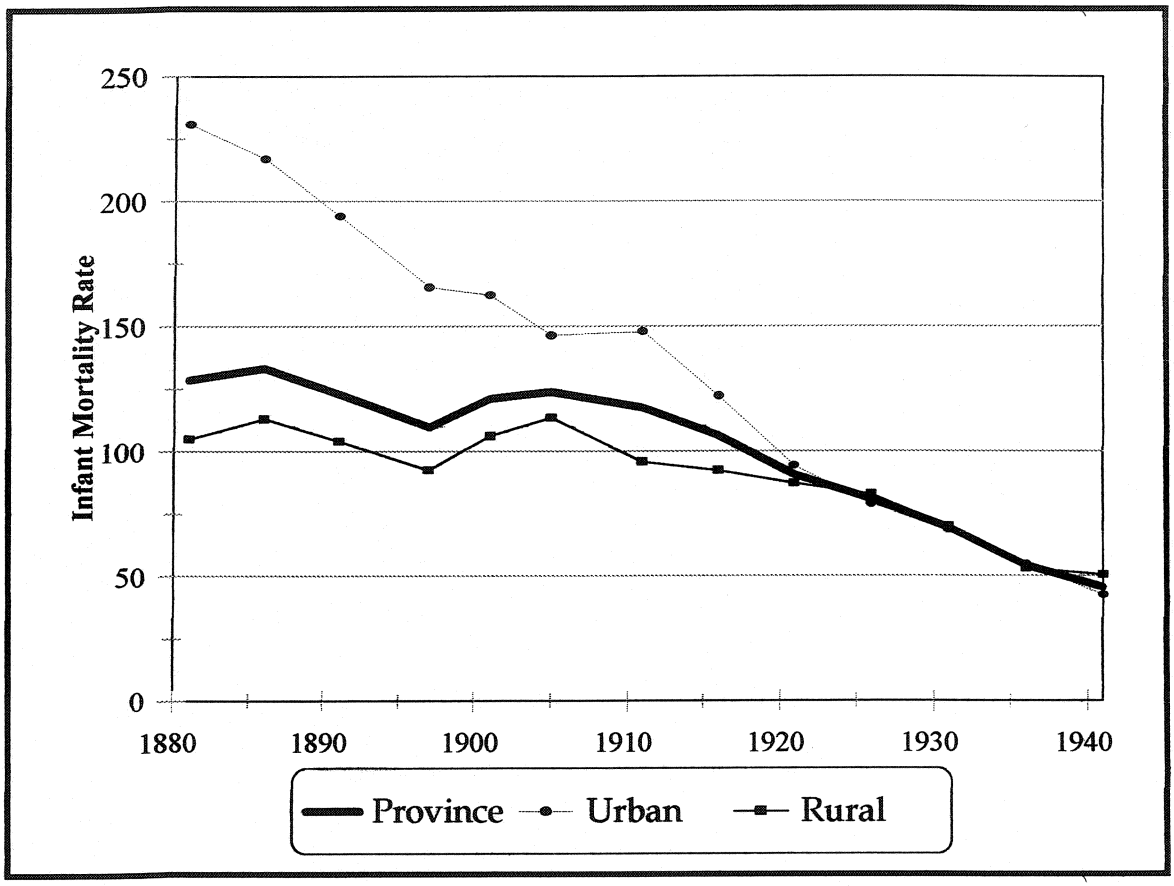


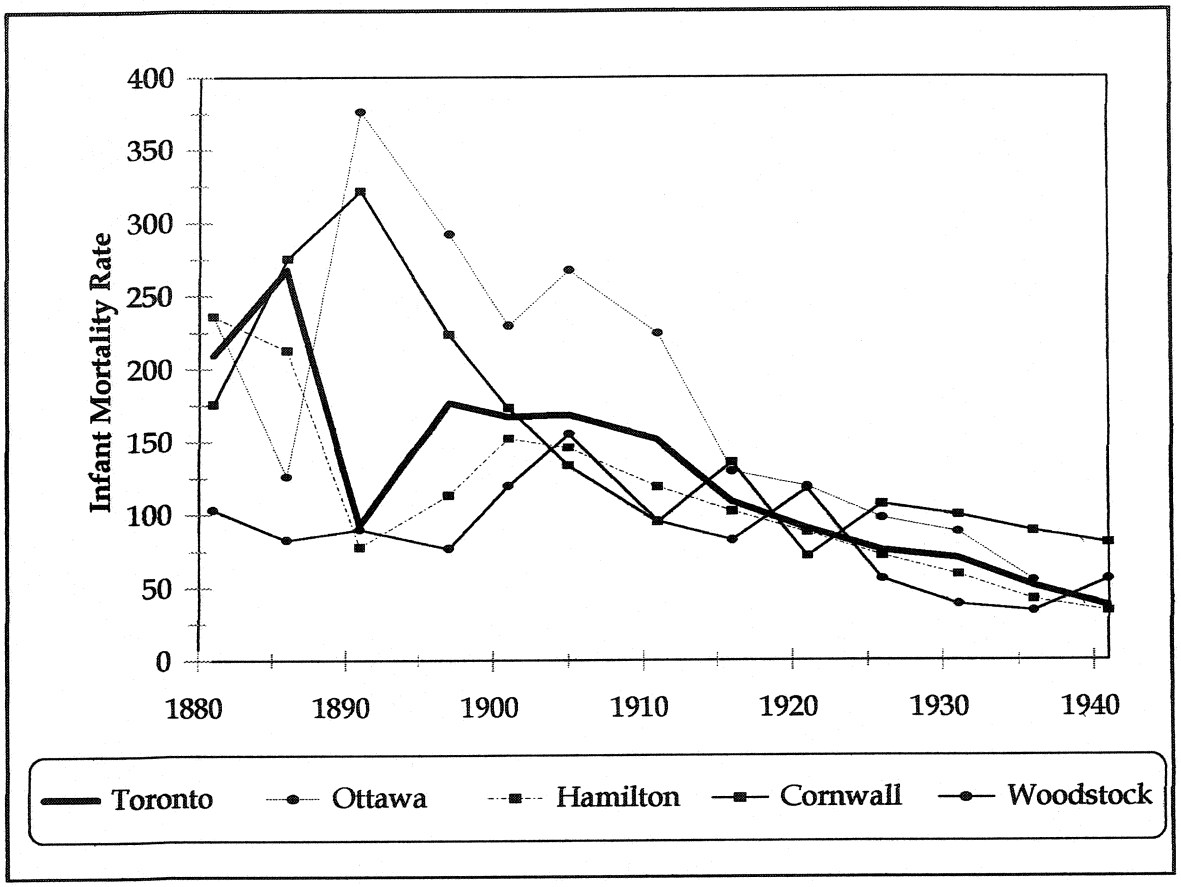
Figure 2.2 - Infant Mortality Rate in Ontario, 1881-1941



Note: The provincial infant mortality rate for 1891 was considered erroneous (see endnote #4) and so an approximate value was determined by averaging the rates for 1881, 1886, 1897, and 1901.

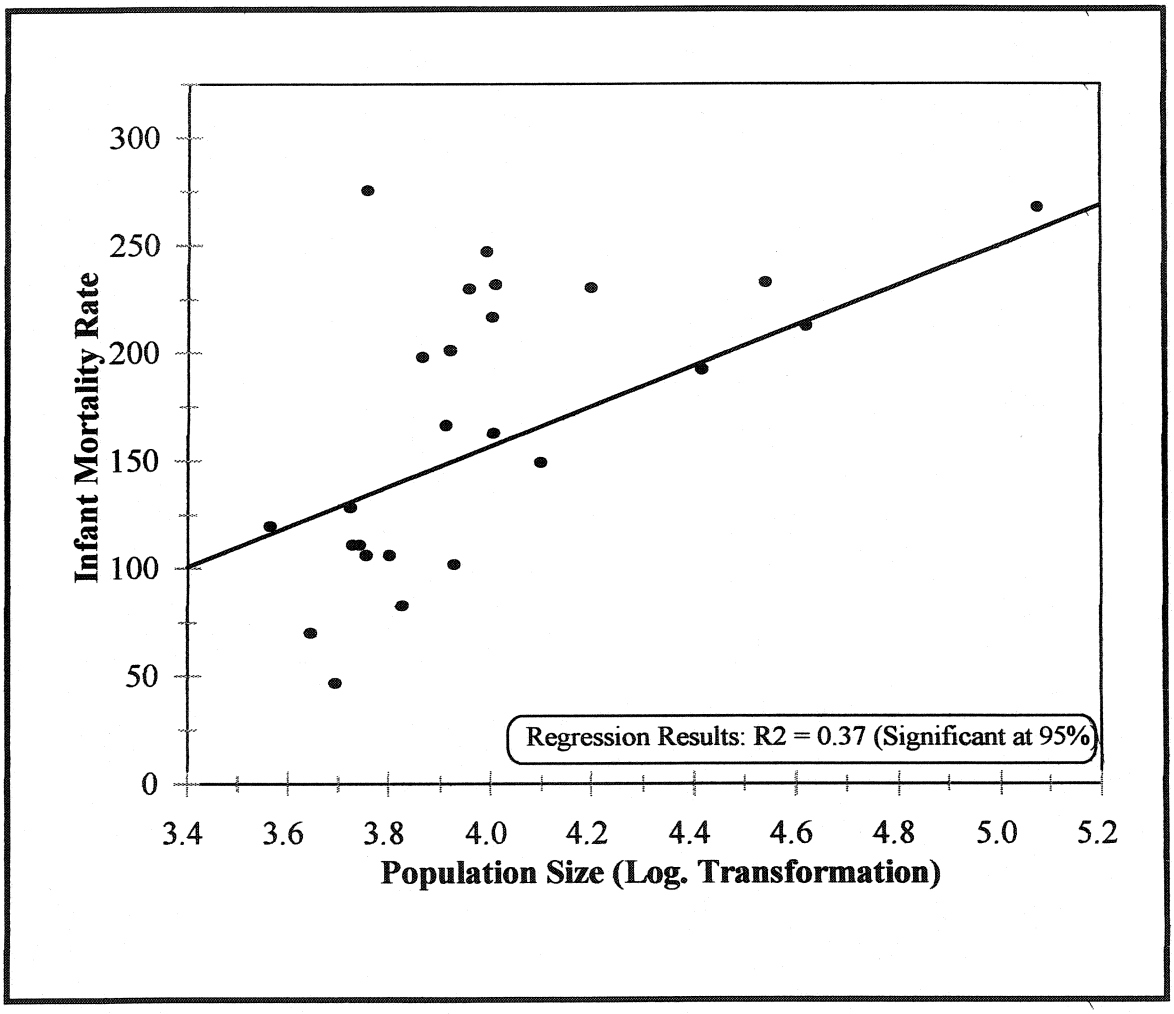
Source: Compiled by author from Registrar General (Ontario), *Annual Report of Births, Marriages and Deaths*, 1881-1941.

Figure 2.3 - Infant Mortality in Select Ontario Cities, 1881-1941



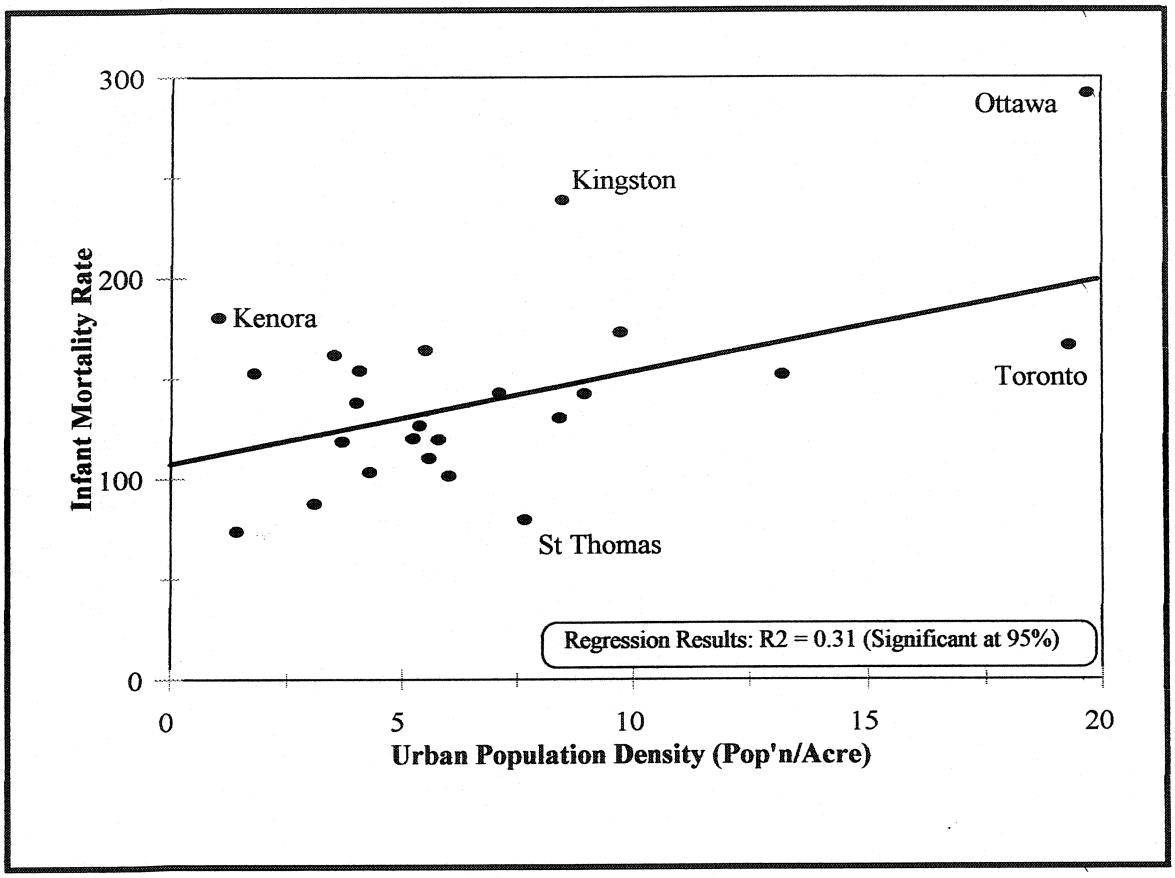
Source: Compiled by author from Registrar General (Ontario), *Annual Report of Births, Marriages and Deaths*, 1881-1941.

Figure 2.4 - Infant Mortality and Population Size (Logarithmic Transformation), Ontario Urban Communities, 1886



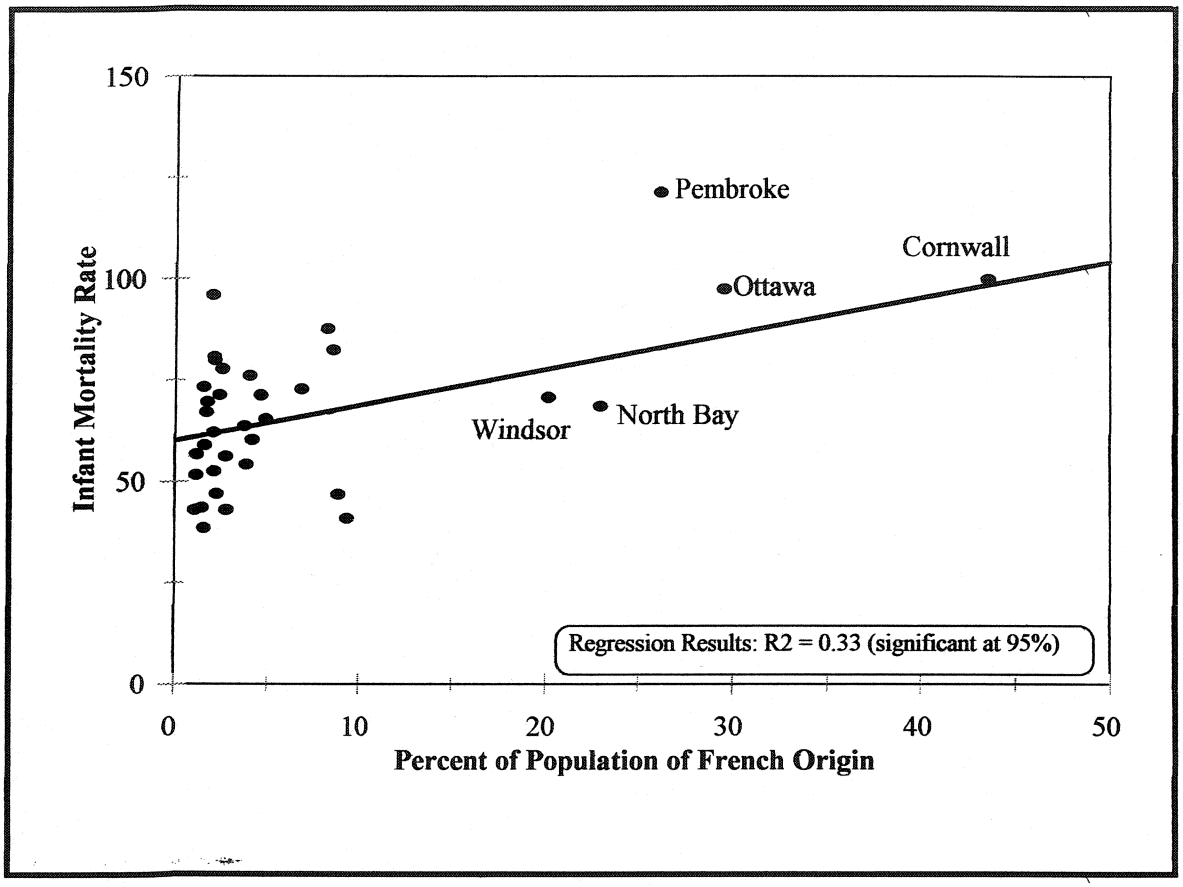
Source: Compiled by author from Registrar General (Ontario), *Annual Report of Births, Marriages and Deaths*, 1881-1941.

Figure 2.5 - Infant Mortality and Population Density, Ontario Urban Communities, 1901



Source: Compiled by author from Registrar General (Ontario), *Annual Report of Births, Marriages and Deaths*, 1881-1941.

Figure 2.6 - Infant Mortality and the Proportion of French-Canadians, Ontario Urban Communities, 1931



Source: Compiled by author from Registrar General (Ontario), *Annual Report of Births, Marriages and Deaths*, 1881-1941.

CHAPTER 3: THE DETERMINANTS OF INFANT AND CHILD MORTALITY IN TORONTO, 1901

3.1 - INTRODUCTION:

At the turn of the twentieth century, mortality rates in Canadian cities, like elsewhere in North America, were high relative to present standards. Between ten and twenty percent of all babies born in most Canadian cities did not live to their first birthday. In some notoriously unhealthy cities like Montreal and Ottawa the rate was much higher still. Toronto, ranked second behind Montreal in population size in 1901, had a much more favourable infant mortality rate (IMR) even though over 700 infants (under one year of age) died, and a further 250 young children (between one and five years) died in the city that year. Comparable rates for American cities are difficult to unearth, but Toronto's IMR of 167 (per 1000 live births) was commensurate with that of many large and mid-sized US cities, such as Boston (173), Milwaukee (168), New York (171), and Philadelphia (162) (Meckel 1990, p.106). In terms of mortality, therefore, Toronto was typical of mid-sized North American cities. In North America, in the last three decades of the nineteenth century, mortality rates for adults, youths, children and infants, in succession, began a secular decline that, although much slowed, continues today. At the outset of the twentieth century, Canada was at the cusp of its own infant mortality decline (McInnis 2000, p.567-571; Mercier 2003).

From at least the beginning of the industrial era, and up to the 1920s, it seems that

cities had much higher mortality rates than rural areas, although any precise reckoning of rural rates is made problematic by lower levels of vital statistic registration in the countryside (Emery 1993). Cities were at the centre of an institutional public health movement that strove to improve the health of the population. Numerous initiatives were introduced, such as improved and centralised water supply and filtration, sewage removal and treatment, refuse collection, housing regulations, vaccination and inoculation programs, public education, and more. In some cases these initiatives were also directed to help 'beautify' the city as part of urban reform, and others were designed to improve the moral health of the city. Fundamentally, however, these public health initiatives were introduced because a growing number of citizens, politicians and reformers were coming to understand the causes behind the high rates of mortality. Even when their understanding of the aetiology of disease was misleading (ie. miasmic theory), the initiatives reformers undertook were cumulatively effective.

Due to limitations in local death registration data, there are only a few studies which focus on the health of individual American or Canadian cities, as measured by infant or child mortality (Leavitt 1982; Mercier and Boone 2002; Thornton and Olson 2001). As a result, in our quest to understand the determinants of why some children died and others did not, we have, to date, mostly been forced to rely on national studies utilising published

aggregate-level data, with all the ecological problems that come from that. In contrast, this paper takes a local-level case-study approach to the study of infant and child mortality which allows for much greater analytical precision. The case-study is the city of Toronto in 1901. Constructed from a complete enumeration of individual-level death records for Toronto's infants and children under the age of five, this paper provides a rare opportunity to assess the relative importance of the determinants of mortality. The objective of the paper, therefore, is to investigate the determinants of infant and child mortality in Toronto, 1901 and, in particular to determine the relative importance of socio-cultural, socio-economic, and environmental factors such as religion, class and household crowding. Most contemporaries, and many later observers, assumed that socio-economic, and related environmental, factors were of particular importance. However, recent studies of Canadian cities, such as Montreal and Ottawa, have highlighted the importance of cultural practices, particularly within the French-Canadian population, to the high rate of infant mortality (Mercier and Boone 2002; Thornton and Olson 2001). This study of Toronto provides a useful comparison because it essentially controls for the influence of French-Canadians, of whom there were very few in Toronto in 1901. With the negative influence of French-Canadians accounted for, this paper can more fully investigate the relative importance of class, culture and the environment.

3.2 - LITERATURE:

Broadly speaking, mortality rates in the pre-industrial period were moderately high, and highly volatile, due to large scale epidemics and pandemics, such as those caused by bubonic plague and smallpox (Livi-Bacci 1997, p.49-52). Endemic infectious diseases such as diphtheria, typhoid fever, enteritis, pneumonia, whooping cough replaced these pandemics as the dominant causes of death by the nineteenth century (Lancaster 1990, p.355). Infant mortality rates are believed to have risen sharply in the early nineteenth century due to a general deterioration of the environment resulting from rapid industrialisation and urbanisation (Bairoch 1988, p.228-242). In Europe, infant mortality rates began a secular decline towards the end of the nineteenth century (Corsini et al 1997). Although the specific timing of the equivalent decline for either Canada or the United States is not precisely known, local studies suggest that it began around the turn of the century, and that the timing varied from place to place (Alter 1997, p.92-96). Demographic historians have focussed on explaining these mortality trends, and among the most widely endorsed theories of this mortality transition is a multi-causal one which espouses the benefits of each of i) public health and sanitation innovations, ii) improved living standards and resultant nutritional gains, iii) the changing virulency of specific diseases, and iv) technology and related medical advances (Hardy 1993).

Alongside this focus on mortality trends is a concern for spatial variations. While comparisons have been made between different countries, comparability of data has made this a challenge (Corsini et al 1997). As a result, more attention has been directed at explaining inter-regional variations. Comprehensive studies of inter-regional variations of infant and child mortality of Victorian England (Woods and Shelton 1997), Imperial Germany (Vogele, 1998), Spain (Reher et al1997) and the Netherlands (Wolleswinkel-van den Bosch et al 2000) best characterize this work. The most important finding of these, and other, studies of inter-regional variations of mortality is the persistent, at least until the 1920s, urban and rural differential. For the European continent Bairoch (1988, p.230) estimated that urban infant mortality rates exceeded rural rates by between thirty and sixty percent. Williams and Galley (1995) determined that mortality differentials were greatest between the largest cities and the rural areas of England and Wales, and that the excess urban mortality was attributable to infectious diarrhoeal diseases which were eight times higher in the cities than the countryside. In North America, Weber (1899) estimated that urban infant and child mortality rates in New England were double those of rural areas. More recent analyses have confirmed Weber's assessment (Condran and Crimmins 1980; Mercier 2003).[1]

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1 Some over-estimation of the urban-rural mortality differential is likely because of differential rates of vital statistics registration in cities and countryside, especially in the nineteenth century. For a comprehensive discussion of the development of the vital statistics registration system in Ontario, see, Emery 1993.

While many studies have observed this urban and rural mortality differential, many have also documented variations between individual cities, whether in Europe or North America (Bairoch 1988; Meckel 1990; Alter 1997). What is of greatest importance to this study, however, is how scholars have sought to explain specific mortality levels for any given place. In general, three broad factors have been most often identified; socio-economic circumstances, environmental conditions, and socio-cultural differences.

Changes to the urban environment through public health and sanitation initiatives have made environmental conditions integral to debates about mortality decline. Environmental conditions have also been identified as an important determinant of mortality levels. For example, a central component of the argument for the significance of urban and rural mortality differentials is the deleterious environmental conditions of urban places, especially in the nineteenth and early twentieth centuries (Woods and Shelton 1997). In addition, the importance of urban environmental conditions are highlighted by a number of, mostly British, studies that correlate mortality levels with population density in urban and rural registration districts (Lee 1991; Woods et al 1988). In this sense, density really measures the differential between urban and rural places, rather than inter-urban differences. Nonetheless, Woods (2000) has demonstrated the importance that density, as a measure of the urban-sanitary environment, has on mortality rates, especially those of young children.

In North America, the focus has been more on levels of crowding within the home, as opposed to density surrounding the home. In a study of infant mortality in eight medium and large sized U.S. cities during the 1910s and 1920s Woodbury (1925, p.129) concluded that crowding, even after controlling for material circumstances, elevated levels of mortality by a factor of two. Furthermore, Higgs and Booth (1979) found that in 17 large U.S. cities in 1890 mortality levels were affected by both density and levels of internal household crowding, though crowding was the more important measure, especially for children. Whether the measure used is population density or internal crowding, in either case the relationship with mortality is clear. When greater numbers of people congregate in close proximity, the risk of infectious diseases spreading is high. The most vulnerable population to such infections are the very young. The way that crowding affects childhood mortality varies somewhat between infants and young children, the former are most vulnerable to diarrhoeal diseases, while the latter are more susceptible to respiratory illnesses (Condran and Crimmins 1980). Nonetheless, in either case, the accumulation of large numbers of people into cities, and increased rates of crowding, contributed to higher levels of infant and child mortality.

Inspired by the conclusions of McKeown (1979) that gains in overall standard of living were the driving force behind mortality decline in England and Wales, many historical

demographers have examined the importance of socio-economic factors as determinants of levels of infant and child mortality. Most prominent among these factors is social class. For England and Wales, where the data are comparatively rich, the evidence of a mortality gradient by social class is clear. Those at the upper end of the occupationally-based social class hierarchy had much lower levels of mortality than the working class (Haines 1995; Woods et al 1988). However, the general lack of micro-level data for specific urban places has impeded British historical demographers from assessing whether the social class differences merely reflect variations in environmental conditions. Utilising rare individual-level data for Sheffield, Williams (1992) concluded that the effect on infant mortality of environmental conditions was slightly greater than social class, but both exerted significant and independent effects, and the effects were, in fact, cumulative. In other words, within the city's most insanitary neighbourhood, those among the lower rungs of the social hierarchy (unskilled labourers) had infant mortality rates that were twenty percent higher than their skilled neighbours. When both environment and class are controlled, infant mortality rates were more than fifty percent higher for unskilled labourers living in the most insanitary neighbourhood as compared to skilled artisans living elsewhere in the city (Williams 1992, p.89-91).

In addition to the issues of standard of living and the importance of social class to

mortality levels, maternal employment has also garnered a great deal of attention by historical demographers. Contemporaries agitated about the negative impact that maternal employment had on the health of children, but the results of recent enquiries are more equivocal (Graham 1994; Holdsworth 1997). Much of the contemporary rhetoric about the negative impact of maternal employment centred on the issue of infant feeding, and most particularly the absence of breastfeeding. Mothers working outside the home were simply unable to breastfeed their infants, and therefore increased the infant's risk of exposure, via artificial feeding practices, to contaminated milk and water and thus gastro-intestinal pathogens. However, others argue that infant and child mortality levels would have been much higher, especially among those in the lowest social classes, had mothers not ventured out of the home to seek employment and, in turn, bring home much needed family income (Dyhouse 1978; Garrett 1998).

While breastfeeding has been shown to be unequivocally important to levels of infant mortality in the nineteenth and early twentieth centuries, much of the debate about which mothers breastfed and which did not has been, especially in North America, focussed on differences between socio-cultural groups rather than socio-economic ones. The reason for the focus on breastfeeding stems from the observed mortality differentials between socio-cultural groups and the documented differences in breastfeeding rates among these groups

in the U.S. (Woodbury 1925). In the 1920s Woodbury's account of mortality in eight American cities highlighted the importance of socio-cultural differences to infant mortality rates, with infants of Polish, Portugese and French-Canadian ancestry at the upper extreme, and Jewish at the other. Woodbury concluded that marked variations in type of feeding, average earnings of the father, proportions of mothers working outside the home, and degree of household crowding existed among the socio-cultural groups, but after controlling for these factors significant mortality differentials remained (Woodbury 1925, p.124). More recently, Preston and Haines (1991) came to the same conclusion. While social class was an important determinant of child mortality in late nineteenth century America, race and nationality were more important. In Canada, Thornton and Olson (2001) and Mercier and Boone (2002) made the same conclusions about the elevated infant mortality of French-Canadians in late nineteenth and early twentieth century Montreal and Ottawa respectively.

Alongside race and nativity among socio-cultural determinants, religious affiliation has also been determined to be an important marker for groups with high or low infant and child mortality rates. The examples of the French-Canadians, overwhelmingly Catholic, are particularly salient on this point. Catholicism and high levels of mortality are not only highly associated in the North American context, studies of the Netherlands have highlighted the same pattern (Van Poppel 1992; Van Poppel et al 2002). At the opposite extreme, Jews

in both North America and Europe consistently had the lowest levels of mortality of any socio-cultural group, this despite often living in the worst sanitary environments and being near the bottom of the social hierarchy (Condran and Kramarow 1991; Marks 1994). The factor most often attributed to differences in infant and child mortality rates by socio-cultural affiliation is breastfeeding, but this is, by no means, the only one. Other noted differences between socio-cultural groups include, hygienic practices within the home (such as frequency of bathing and regular hand washing), food preparation, fertility practices (such as birth intervals, sibship size, rapid replacement of children that die), and even a reluctance, among Dutch Catholics for example, to accept new ideas about sanitation, hygiene and public health practices (Wolleswinkel-van den Bosch et al 2001, p.1450). Each of these, along with breastfeeding, is believed, to some degree, to have explained some of the socio-cultural mortality differentials observed in past populations.

Emerging from this literature, therefore, are three broad categories of determinants of infant and child mortality; environmental conditions, socio-economic circumstances, and socio-cultural affiliation. Within each broad determinant are a set of factors that contribute to the overall explanation of mortality differentials. In this paper, internal household crowding is used to assess the importance of the environment immediately surrounding the child, while socio-economic factors are assessed by three separate measures, the

occupational class of the household head, whether the mother was employed in waged labour, and the assessed value of the family's dwelling. Finally, the importance of socio-cultural factors on mortality is assessed by the family's ethnic ancestry, their religious affiliation, and their nativity.

3.3 - DATA SOURCES AND METHODS:

Incompleteness, and access restrictions, of local death registrations means that most studies of the determinants of mortality have relied on aggregate-level data. While this is suitable for certain research objectives, most historical scholars would agree that individual-level data, while more cumbersome and time-consuming to collect, are preferable. In Ontario, death registration began following the first Registration Act (1869), but problems plagued the system. At first, both births and deaths were woefully under-registered. A series of important changes to the registration system over the ensuing decades, most importantly the third Registration Act (1896), meant that by the turn of the century death registrations were virtually complete, especially for large urban places like Toronto (Emery 1993, p.31-42). Evidence suggests that registrations were largely complete in urban areas well before the turn of the century. Nonetheless, 1901 was chosen for study because it was the first year that complete and accurate death registrations coincided with the availability of the

manuscript Census.

The published figures for infant and child deaths in 1901 by the Ontario Registrar General were 711 and 245 respectively (Registrar General, 1903). My complete enumeration of the death registry resulted in finding records for 98 percent (698) of infant deaths and 97 percent (237) of the child deaths. The following information was collected, from the death records, for each of the 935 infants and children: name, age at death, religion, father's name, doctor's name, place of residence, and date and cause of death. Utilising the methods of record-linkage, each of the deaths were linked to the 1901 manuscript Census of Canada and to the 1901 municipal tax assessment rolls in order to reconstruct the socio-cultural, socio-economic and environmental (housing) conditions in which the infant had lived and died. A common problem in undertaking record-linkage work for the late nineteenth and early twentieth centuries is that individuals often cannot be traced from one source to another. This is particularly common when the linkage is based on a young child who may have lived no more than a few days. In this case, additional sources such as the annual city directories (1897-1903) and the 1899 fire insurance atlas were used to reduce the number of cases that remained untraceable. There are two key reasons why some deaths could not be linked to other sources. First, nearly 15 percent (95) of the infant deaths occurred in foundling institutions and hospitals, and the death records for these babies

provided no information on which a linkage could be made. Second, in many cases the place of residence was left blank on the death registration. Without the place of residence the process of linkage with other sources was very difficult. All told, 661 deaths (481 infants and 180 children) were eventually traced to the Census and Assessment rolls; a success rate of 71%. We can only speculate on the impact these lost cases may have on the results. Foundlings, most assuredly came disproportionately from the lowest socio-economic classes, thus their omission from the database may result in an underestimation of the importance of both socio-economic and socio-cultural factors for the incidence of infant and child mortality.

Excluding the deaths that occurred in foundling institutions, fully four-fifths of the infant and child deaths were eventually traced to the Census and Assessment rolls. In addition to the data extracted from the death records, these sources provided information on the demographic characteristics of the family, the occupation and earnings of the household head, the socio-cultural background of the parents, and the size and value of the family home. From this, the socio-cultural, socio-economic and environmental conditions of the young child's life were determined.

In order to assess the importance of specific factors to the death of the infants and

children, it was necessary to construct a similar database for a sample of the general population. In the late 1990s a group of Canadian historians and geographers undertook a multi-year project to construct a stratified five percent national sample of the 1901 Canadian Census. The Canadian Families Project (CFP) data, now widely available, is by all accounts representative (Buck et al 2000; Ornstein 2000; Sager 2000).[2] The CFP sample data for Toronto, supplemented with tax assessment information by the author, became the control population for the analysis. The sample is spatially, and otherwise, representative of Toronto's general population.

For each variable observed-expected ratios (OER) were calculated for the number of infant and child deaths. OER measure the relative mortality risk for particular sub-groups within the population. If the observed number of deaths are equal to the expected number then the OER equals 1.0. For groups that have an excess of observed over expected deaths, the OER is greater than 1.0 (see **Methodological Appendix**). In order to create accurate estimates of the number of expected deaths, it was first necessary to control for maternal age. Both the database of deaths and the control population were adjusted so that only 'at risk' households were included. In other words, households without a female of child bearing age (15-49 years) present were excluded because it was unreasonable to 'expect'

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2 I would like to thank Eric Sager, as head of the Canadian Families Project, for providing a copy of the CFP sample for the city of Toronto ahead of its public release.

them to have had an infant or child die. The resultant death database consisted of 649 households, and the control population 1439 households.

Since certain subgroups of the population had higher rates of fertility, it was necessary to control for these differentials because they affected the number of expected deaths. Families with higher fertility are simply at greater risk of having one of their children die. For instance, families of Italian or eastern European descent had much higher than average fertility rates, and much higher still than those of German or Scottish descent. As a result, the adjusted number of expected deaths for the Italian and eastern European families were double what they would have been had fertility not been controlled for. Since fertility practices (ie. use of birth control, family limitation, etc.) are often culturally and class-based, it was necessary therefore, to control for differential fertility rates by socio-cultural and socio-economic background. Without numbers of births for each subgroup of the population, a method of indirect estimation was used to construct fertility differentials. For each population subgroup, the average number of surviving children, under the age of five, per woman of child-bearing age was compared to an estimated number of surviving children assuming constant fertility. The resultant 'fertility factor', essentially an observed-expected ratio of surviving children, was used to adjust the number of expected deaths (see **Methodological Appendix**). Significant fertility differentials were observed, and controlled

for, by occupational class, socio-economic standing, ancestral origin, religion, and birthplace. Although the influence of fertility on levels of mortality by social class and socio-cultural affiliation is important and is, therefore, necessarily controlled for in this analysis, it is not a primary concern of this research. However, future research on the relationships between childhood mortality and social class and culture could usefully incorporate analyses of the importance of fertility differentials.

Simple 2-way Chi-Square analyses were used to test the significance of independent bivariate relationships between the socio-economic, socio-cultural and environmental factors, and childhood mortality. Having established the independent influence of these factors a multivariate analysis was undertaken to assess their combined influence. A logistic regression model was estimated for the dichotomous outcome variable; households with/without an infant or child death. The purpose of logistic regression is to identify whether each explanatory variable renders the outcome measure more or less likely in the context of the other explanatory variables. Logistic regression is the most appropriate method of multivariate analysis because of the dichotomous nature of the dependant variable, and the fact that the explanatory variables are both continuous and categorical (Pampel 2000; Wrigley 1985). All variables found to be significantly related to childhood mortality in the bivariate analyses were included for multivariate analysis. Variables were

entered into the model in a forward stepwise manner, and remained in the model if the Wald inclusion test statistic was 0.10 or below (Wakefield 2000).

3.4 - SOCIO-ECONOMIC AND ENVIRONMENTAL INFLUENCES:

3.4.1 - Occupational Class and Maternal Employment

Socio-economic circumstances were surely an important factor in determining which families would have an infant or child die prematurely. Reported income would be the ideal measure of socio-economic standing. While the Canadian Census enumerators did ask households to report earnings from wages and salaries (not other income), Sager (2000) has noted that only those who were categorized as employees were expected to respond. About fifty percent of household heads that reported an occupation also reported some earnings, the remaining fifty percent were either employers or working on their own account (self employed) (Sager 2000, p.236). As a result, it is not possible to assess mortality by earnings for the entire range of occupations. Because of this inconsistency of the Census income variable, two other measures of socio-economic status were used, the occupational class of the household head and the assessed building value (in dollars) of the family home. Based on the findings in England and Wales, we would expect occupational class to be an

important determinant of mortality (Haines 1995; Watterson 1988; Woods et al 1988; Woods 2000).

Over 550 unique occupations were listed in the Census for Toronto by the more than 1400 sampled household heads. For analytical purposes, these occupations were grouped into seven classes based on the classification system developed by Harris (1996) in his study of early twentieth century Toronto. In this framework, a distinction is made between owners and managers of capital, on the one hand, and workers on the other. Those who were self-employed stand apart. The middle class, those able to use education and specific skills to improve their position, is comprised of professionals and supervisors. In all, seven classes are used (**Table 3.1**).[3]

After controlling for differential levels of fertility, there do appear to be mortality differences by occupational class, but the size of the sample precludes these from being statistically significant (at the 95 percent confidence level) (**Table 3.1**). Both the middle-class professionals and the white-collar clerical classes had lower than expected mortality,

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3 The most common, and representative, occupations listed under each classification are as follows, i) Self Employed: baker, butcher, grocer, traveller; ii) Owners and Managers: banker, manager, merchant; iii) Professional - Middle Class: accountant, barrister, physician, teacher; iv) White Collar (Clerical): book keeper, clerk, stenographer; v) Blue Collar (Skilled and Semi-Skilled): carpenter, driver-teamster, machinist, printer, shoe maker; vi) Blue Collar (Unskilled): domestic (various types), labourer (various types); and vii) Miscellaneous (Other): retired, not given.

while the unskilled working-class had markedly higher than expected mortality. Each pattern is consistent with our understanding of occupational-class differences. Surprisingly, however, there were slightly more deaths than expected for the highest occupational class, the owners and managers. Despite the statistical insignificance, the relationship between mortality and occupational class in Toronto is compelling. Social class seems to have had a much less important role in mortality in Toronto than in Britain (Woods et al 1988).

Maternal employment, elsewhere found to be associated with infant mortality rates, was not important in Toronto. Based on the literature, two somewhat opposing effects on mortality might be expected from female waged labour (Dyhouse 1978; Holdsworth 1997; Woodbury 1925). On the one hand, working mothers brought additional income into the home to boost the family's socio-economic position and to lessen the impacts of poverty. On the other hand, more time spent outside the home, or in some cases working at home in the putting-out system, necessitated alternative, and perhaps less adequate, care for young children (Frager 1992). In the case of Toronto, it seems that the former effect was paramount. In cases where women were employed in waged labour they were, most often, the sole bread-winners for the family and were employed either in the skilled or unskilled labouring classes, or were themselves self-employed. Common occupations listed in the Census for women were, among others, seamstress, dressmaker and various other textile

related occupations, and also printer, domestic servant, laundress, labourer, waitress, saleslady, barber, hotel or boarding house keeper. All told, however, in only a small fraction (5.6%) of the Toronto households was the woman employed in waged labour. The proportion was even smaller (3.5%) for households with an infant or child death. Analysis of female/maternal labour provides little further explanatory strength to the understanding of mortality differences. These results suggest two things. First, for women of child-bearing age, participation in the workforce was relatively low. Second, for those families that suffered an infant or child death, the proportion of women employed was even lower. In families that had a death, more often the woman was at home with the children, and forewent additional family income.

3.4.2 - Assessed Building Value

While occupational class provided some insight into the way that socio-economic status influenced mortality, another measure of socio-economic standing, the assessed value of the family home, provides another way of assessing mortality differentials. In lieu of reliable income or wealth data, assessed building value has been shown to be an effective predictor of mortality in turn of the century Ontario (Mercier and Boone 2002). Appraised annually for property tax purposes, the assessed value of home is an accurate measure of a

family's relative socio-economic standing (Harris 1996, p.287). We would expect mortality to be highest in homes with the lowest assessed values, and vice versa for the most expensive homes. This is, in a general way, the observed pattern for 1901 Toronto. However there are some variations within this broader pattern. The average assessed value of houses with an infant or child death in Toronto in 1901, was $750 (median: $500), and values ranged from less than $50 to greater than $8,000. In contrast, the range of assessed values of sampled houses (without deaths) in Toronto extended higher than for those with deaths, and the average was $967. A difference of means test confirms this difference to be statistically significant.

Overall, significant differences exist between the observed and expected numbers of deaths. Families living in houses assessed at less than $300, had significantly higher than expected mortality while, on average, those living in houses assessed at greater than $301 had lower than expected mortality (**Table 3.2**). While the group at greatest risk of mortality was living in homes assessed at less than $300, the group with the lowest risk was actually in the range from $300-600. Moving up the assessed value scale meant a slight increase in risk rather than decrease. In other words, for those households living in homes assessed at greater than $900 there was essentially no benefit in terms of reduced mortality risk. In all,

it appears that there was a critical threshold at which mortality risk changed at about $300.[4] This threshold may appear to be low given the range of assessed values in Toronto in 1901, though a substantial proportion of families lived in homes below this level. As much as one-fifth (20.8%) of all families in the city lived in houses assessed below $300. The proportion was even higher (29.2%) for those families with an infant or child death. Assessed values, the best single measure of a household's socio-economic position, did matter, therefore, but not continuously. The critical issue in determining mortality risk was whether the household fell into the bottom fifth of the population.

3.4.3 - Crowding and Family Size

Intuitively, we would expect household crowding to have an effect on mortality, because the chance of spreading infectious respiratory and gastro-intestinal diseases increases when more people are crowded together. A contemporary study found that in Baltimore in the 1920s, infant mortality rates were two and a half times greater in crowded homes (more than two persons per room) than in non-crowded homes (Woodbury, 1925, 125). This mortality differential, by crowding, has generally been most apparent for infants

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4 Utilising smaller class sizes ($100) this threshold at about $300 becomes more apparent. The O/E Ratios are as follows: $0-100 (1.248), $101-200 (1.086), $201-300 (1.363), $301-400 (0.893), $401-500 (0.806), $501-600 (1.003), $601-700 (0.766), $701-800 (0.932), $801-900 (1.348), >$901 (0.969).

and young children and for specific causes of death (gastro-intestinal and respiratory diseases). Crowding was, not surprisingly, high in Toronto like many other large cities in North America at the turn of the twentieth century. The published Census of Canada allows for the calculation of a crude measure of crowding, persons per dwelling, which does not account for the physical size of the dwelling, but does allow for comparisons with other cities in Ontario. In 1901, Toronto was among the most crowded cities with an average of 7.2 persons per dwelling, a level surpassed only by two small Ontario cities. By way of comparison, Ontario's second and third largest cities, Ottawa and Hamilton, averaged 6.0 and 4.9 persons per dwelling respectively, while the provincial average was 5.1. In the period 1891-1941 Toronto was consistently among the five most crowded cities in the province.

While the above measure does provide some useful comparisons, it is not ideal. A more significant measure of crowding is the average number of persons per room. Families living in crowded quarters were expected to experience elevated infant and child mortality through an increased risk of the spread of illness from person to person. On the whole, households in Toronto averaged 0.80 persons per room (median = 0.71). An arbitrary but generally accepted threshold for crowding is more than one person per room (ie. homes above this threshold are deemed *crowded*) (Lepore 1998). In Toronto, 80% of households

had less than one person per room. In contrast, the average degree of crowding for households with an infant or child death was significantly higher than the 0.80 persons per room for the general population. The average measure of crowding for households with a death was only slightly below the arbitrary crowded threshold of 1.0 (0.98, median = 0.89). A difference of means test confirms that, on average, households with a death were more crowded than those without.

While one person per room is the generally accepted threshold for household crowding, in Toronto the critical point where mortality diverges between elevated and decreased levels, occurs instead at 0.70 persons per room (**Table 3.3**).[5] Households with an occupancy rate of less than 0.70 persons per room experienced 178 deaths, 45 percent fewer than expected. Above this threshold the pattern is reversed; observed deaths outnumber expected deaths. The difference in these observed-expected mortality ratios is statistically significant (as determined through chi-square analysis). It is important to note that, while houses with more than 0.70 persons per room had higher than expected mortality, a smooth upwards mortality gradient does not emerge. Mortality risk does not necessarily increase as households become more crowded beyond this threshold. This is an intriguing finding

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5 Utilising smaller class sizes (0.10 persons per room) this threshold at about 0.70 persons per room becomes more apparent. The O/E Ratios are as follows: <0.50 (0.529), 0.51-0.60 (0.546), 0.61-0.70 (0.652), 0.71-0.80 (1.311), 0.81-0.90 (1.222), 0.91-1.00 (1.098), 1.01-1.50 (1.675), 1.51-2.00 (2.052), >2.01 (2.391).

since it parallels that found for assessed value. In each case, it is possible to draw a fairly clear line between households in terms of the health risks that their infants and children faced.

Crowding had a direct effect on mortality, but was itself determined largely by family size and socio-economic circumstances. In theory, while a large or small family, or household size, in and of itself, should not impact directly on the likelihood of an infant or child death, the total number of persons in a household can, indirectly, affect mortality when combined with limited financial resources through greater levels of crowding. Toronto evidence points to a positive relationship between the number of people residing in a house and mortality risk. A difference of means test reveals that the average household size of families with a death (5.9 persons) was significantly higher than that for households without a death (5.1). In general, the total household size was comprised of an immediate family, and in varying cases, any number of extended family members, boarders, lodgers, or live-in domestic help. An examination of the mortality risk for households with different immediate family sizes indicates that larger families, those greater than seven persons, had mortality levels that were 18 percent higher than expected (**Table 3.4**). The opposite was true for small families. This positive linear relationship between immediate family size and mortality supports the crowding hypothesis. In general, with larger families came more

crowded living conditions within the home. Small families averaged 0.6 persons per room, while large families averaged more than twice that (1.3). In other words, large families, per se, were not the problem. Rather, it was because large families were more likely to be crowded that they faced a higher mortality risk.

Based on the findings of the size of the immediate family, we would expect that the presence of extended family members, and boarders and lodgers, would further exacerbate the crowding problem, and again contribute to greater mortality risk. In fact, both the presence and number of extended family members within the household was associated with a greater risk of infant or child deaths. The average number of extended family members resident in households was significantly higher for those with a death (2.8 vs. 1.5). For households that took in boarders or lodgers, the average number of boarders was significantly higher for those households with a death (2.7 vs. 2.2). On one hand, taking in extended family or boarders may have helped defray housing costs and therefore improved the relative socio-economic circumstances of the family, while on the other hand these improved circumstances may have been outweighed by an increase in household crowding. Evidence for the United States supports the crowding hypothesis in that the influence of boarding was generally negative; mortality was 15 percent higher for families with boarders (Preston and Haines 1991, p.158). In Toronto, having one or two boarders actually

decreased the mortality risk by about twenty percent, presumably because the extra family income via rent helped the family out financially, while at the same time the boarders did not significantly add to the overall level of crowding (**Table 3.5**). With three or more boarders, however, mortality risk was 93 percent higher than expected, a statistically significant increase. In this case, therefore, the increased crowding far outweighed the extra income that the family received. Additionally, at the turn of the twentieth century some families still employed live-in domestic help. In Toronto, one in ten households employed at least one live-in servant. Preston and Haines (1991, p.127) found the presence of live-in domestic help lowered the mortality risk of children in the United States by 14 percent, though the significance of this finding disappeared once other factors were controlled. In Toronto, there was no significant difference in either the proportion of households that had live-in help, or the average number of servants, between those that had a death and the general population.

In summary then, household crowding, as measured by the number of persons per room had a clear and negative impact on the chances of infant and child survival. For the most part, larger immediate families, the presence of extended family members, and the presence of multiple boarders and lodgers were each associated with an increased risk of mortality. In each case, the additional people in the home increased the level of crowding,

and at some level the adverse effects of crowding outweighed any potentially positive effects of increased economic resources for the family.

3.4.4 - Crowding and Assessed Values: Evaluating the Determinants of Mortality

We have seen that the economic status of the household, and the degree of crowding within the dwelling each had an impact on the levels of infant and child mortality. Which of these influences was more important, and how were they related? Lower-status families tended to live in more crowded residences with several persons per room, as compared with the more affluent. In Toronto, the relationship between crowding and assessed building values is clear, and a consistent gradient exists. The more valuable properties were, on average, less crowded, and the most spacious homes were the most expensive. For example, the most spacious homes (those with less than 0.5 person per room) were, on average, assessed at $1159, while the most crowded homes (greater than 1.5 persons per room) were assessed at less than $450. This pattern exists irrespective of mortality though, not surprisingly, at any given level of crowding the average assessed value is lower for those households with a death than for those without. The same can be said for assessed value. At any given level of assessment, the degree of crowding is higher for those households with a death than for those without.

While it is apparent that crowding and assessed values are closely related, and that they are both important determinants of mortality, an evaluation of which is the more important determinant remains. For all levels of assessed value, mortality is higher in the more crowded dwellings. This pattern is strong and consistent. Controlling for the level of crowding, on the other hand, we see no significant variation in the level of mortality by assessed values (**Figure 3.1**). In other words, the effect of assessed value on mortality is explained entirely by the variations in crowding. As such, it seems that crowding is, of the two, the more important determinant of mortality in Toronto.

3.4.5 - Housing Tenure

Quite independently of the issues we have considered to this point, we might expect that mortality would be lower among families that owned, rather than rented, their place of residence. For families that were owner-occupiers (freehold) of their place of residence the observed number of infant and child deaths was significantly lower than expected. Conversely, mortality risk was highest for families renting their homes. We have already seen that assessed value was an important factor, so perhaps this result is meaningful because those homes that were owner-occupied were assessed much higher than those that were rented. On average, owner-occupied homes were assessed 75 percent higher than

rented homes. It is apparent from the cross-tabulation of housing tenure and assessed value that, irrespective of tenure, mortality risk declines as assessed value increases (**Table 3.6**). For both types of tenure, mortality is highest for those homes assessed at less than $300. A similar pattern emerges for the relationship between mortality and housing tenure, when level of crowding is accounted for. Owner-occupied homes averaged 0.9 persons per room, and rented homes averaged 1.0 persons; a statistically significant difference. As we would expect, mortality risk is much lower in the most spacious homes, and higher in the most crowded homes, irrespective of tenure (**Table 3.7**).

In general, the effect of assessed value on mortality is greatest for those homes that are rented. An intriguing exception to this pattern, however, is that for the homes assessed the lowest (less than $300), mortality is actually higher for those homes that are owner-occupied. These homes are certainly crowded (1.28), and are more crowded than their inexpensive rented counterparts (1.12). However, what is also distinctive about this group of owner-occupied homes is that they are predominantly located on the periphery of the city. Many are, presumably, the owner-built working-class suburban homes documented by Harris (1996). These peripheral areas, labelled as 'shacktowns' by public health authorities, provided the opportunity for working-class families to move to suburban locales and own their own home. The difference between these suburban areas and the more traditional

notions of suburbia were that these homes were actually built by the family over the course of several years, and were often on unserviced lots. The lack of sanitary services, and the often crowded conditions within these one or two room 'shacks' probably explains the high rate of mortality.

3.5 - SOCIO-CULTURAL INFLUENCES:

3.5.1 - Ethnic/Ancestral Origin

Socio-economic and environmental circumstances obviously played a significant role in determining the incidence of mortality. What about socio-cultural differences? As a nation built on immigration, Canada has long been concerned about the connections between individuals and their ancestral origins. A reflection of that is the Canadian Census' recording of an individual's ethnic/ancestral origin even if the individuals' family had been resident in Canada for many generations. In fact, only recently have Canadians been able to record 'Canadian' as their ethnic/ancestral origin. Because of this, however, ancestral origin is one of a number of labels that can be used to capture socio-cultural differences.

In Toronto in 1901, there was a significant mortality differential by ethnic origin

even after controlling for fertility differences. Households were divided, by ancestral origin, into four main groups; i) Britain, ii) Eastern European, iii) Western European, and iv) a small grouping that includes miscellaneous 'other' ancestral origins (African, 'not specified', etc.). Chi square analysis reveals that the observed infant and child mortality distribution was significantly different from the expected for the four groupings (**Table 3.8**).

Within the British group, some variation existed by nationality, but on the whole, observed mortality was commensurate with the expected distribution. Households of English descent, for example, had 315 infant and child deaths in Toronto in 1901. After controlling for maternal age and differential fertility rates, the expected number of infant and child deaths was approximately 317, a difference of less than one percent. In contrast, households of Protestant Irish descent had 14 percent fewer deaths than expected. While the mortality distribution was as expected for the English population, and lower than expected for the Protestant Irish, it was slightly higher than expected for both the Scottish and Irish Catholics. Taken as a whole therefore, the latter two groups cancel out the effect of the Protestant Irish, and as a result mortality for descendants of the British Isles was as expected.

Mortality was significantly lower than expected within households of eastern

European descent, notwithstanding their comparatively high fertility rates. In fact, observed mortality for east European households was roughly one quarter (25%) the expected mortality. It should be noted that significant overlap exists between this ancestral group and religion as households in Toronto originating from eastern Europe were almost exclusively Jewish. In contrast to those of east European descent, those from the major western European countries, including France, Germany and Italy had many more deaths than expected. This excess mortality is most obviously attributed to the elevated rates of households of both German and Italian descent. Observed infant and child deaths for German and Italian households were nearly three times higher than what was expected given their population size and fertility rates. While clearly significant, these mortality differentials may not, in fact, be unique to ethnic origin, rather they may be a factor of religious affiliation.

3.5.2 - Religion

A significant independent mortality differential existed by religious affiliation, even after differential fertility rates were accounted for (**Table 3.9**). Much of this difference was driven by the significantly lower than expected mortality of the Jewish population. Jews represented only 2% of households. After controlling for a fertility rate that was twice the

city average, we would expect nearly 4.5% of infant and child deaths to be in Jewish households. Instead, Jews accounted for only 1.1% of deaths. Although the number of Jewish households (and therefore infant and child deaths) is small, the relationship is statistically significant and important to the overall relationship between mortality and religious affiliation. In direct contrast to this Jewish pattern is that of Roman Catholic households. Again, after controlling for the comparatively high fertility rate of the Catholic population, mortality was 16 percent higher than expected. These two patterns, high mortality of Catholics and low mortality of Jews, are consistent with observations made elsewhere. Catholics in the Netherlands and in Francophone Canada have been associated with elevated levels of mortality (Van Poppel 1992; Thornton and Olson 2001; Mercier and Boone 2002). Jews in the United States, as well as in Britain have been highlighted because of their consistently low levels of mortality (Condran and Kramarow 1991; Marks 1994; Woodbury 1925).

By far the majority of Toronto's population (80.1%) in 1901 belonged to one of the Protestant religions (Baptist, Anglican, Methodist and Presbyterian). As a whole, mortality rates were on par with what was expected for this group. However, some variation did exist within the group as Methodists and Presbyterians had higher than expected mortality rates, 14% and 7% higher respectively, and Baptists had lower than expected mortality rates

(-12%). Overall therefore, it seems that while there are slight differences between the Protestant faiths, the most glaring mortality differences existed between Catholics and Jews.

3.5.3 - Birthplace/Nativity

Birthplace, or nativity, is another measure which can be used to capture socio-cultural differences. Over half (54%) of infant and child deaths occurred in homes where the household head was born in Ontario, and a further 5% occurred in homes where the household heads were born elsewhere in Canada or the United States. As such, 60% of deaths occurred in houses of native-born North Americans where immigration had occurred at least one generation previously. The remaining 40% of deaths occurred in homes where the head of household was an immigrant to Canada. The vast majority (87%) of immigrants came directly from Britain, with the remainder immigrating from various other European countries.

In general, after accounting for fertility differences, infant and child mortality was lower than expected for families that immigrated to Canada, as compared to those of native birth, Ontario in particular (**Table 3.10**). Within the grouping of immigrants, however, significant variation exists. Despite variation within the British immigrants, as a whole their

observed deaths were commensurate with the expected rate. Confirming the results of the ancestral origin and religion analyses, Eastern European immigrants had significantly lower than expected mortality, while those from the rest of Europe had significantly higher than expected mortality. In households where the parents immigrated from eastern Europe, 27 deaths were expected and only 5 died. Conversely, household heads immigrating from other European countries had three times as many infant and child deaths as expected. While the numbers for these groups are small, the pattern is significant nonetheless.

Of the household heads born in North America, three distinct groups emerge; American- born, Ontario- born, and those born elsewhere in Canada. Infant and child mortality for those born in the United States was higher than expected, while those born elsewhere in Canada had fewer deaths than expected. This lower than expected mortality for Canadian-born household heads is surprising as this group includes many households where the parents were born in Quebec, a province where mortality rates were notoriously very high (McInnis 2000).[6] Most surprising, however, is the comparatively high mortality for Ontario-born families. Infant and child mortality among the Ontario-born was 11% higher than expected. This relative inability of Ontario household heads to preserve the lives

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6 Only one quarter of Toronto's household heads born in Quebec were of French ancestry. As many as three quarters of these Quebec-born household heads were of British or Irish descent, suggesting that this was a special sub-population of Quebecois.

of their children, compared to immigrant families, is counterintuitive (Preston and Haines 1991; Ward 1971). Given that there would be no language barriers for this group, and that they would have been familiar with local health resources had they needed assistance, we would expect mortality to be much lower for this native-born group.

3.6 - SOCIO-CULTURAL, SOCIO-ECONOMIC AND ENVIRONMENTAL CIRCUMSTANCES: MULTIVARIATE RESULTS

Having determined the independent significance of socio-cultural factors to infant and child mortality in Toronto, can we explain these mortality differentials by measures of affluence and crowding? In other words, was the low level of mortality of the eastern European Jews due to greater affluence, and living in less crowded conditions, than others, especially the Catholics? In fact, the truth is quite the opposite. While the median assessed value of homes of Catholic families were the lowest of any socio-cultural group, the homes of Jews and Anglicans were also well below the city average (**Figure 3.2**). Of these three groups, only the Catholics had high levels of infant and child mortality. Similarly, crowding does not seem to satisfactorily explain these socio-cultural variations in mortality. Again, the homes of Catholics are the most crowded, on average, but not much more so than for Jews (**Figure 3.3**). These two socio-cultural groups then, provide interesting contrasts in experience. For both Jews and Catholics a high proportion lived in crowded homes, and

their homes were, on average, the poorest in the city, but their levels of mortality could hardly be more different. So, while crowding and poverty may partially explain the excess mortality of Catholic families, these variables do not adequately explain the overall relationship between socio-cultural differences and levels of infant and child mortality.

Similarly, we would expect that those household heads born in Ontario, would have adopted hygienic and household practices that would adapt them to the local environment and conditions. The fact that Ontario-born mortality was higher than for immigrants, seems to suggest that this did not occur in turn of the twentieth century Toronto. Perhaps other factors were at play. It is plausible, though contradictory from evidence from other jurisdictions, that native born household heads in Ontario were economically disadvantaged compared to recent immigrants. On the contrary. Irrespective of mortality, the families of Ontario-born household heads were, on average, living in less crowded and more expensive homes than their counterparts from abroad (**Figures 3.4 and 3.5**). In other words, despite advantageous socio-economic and living conditions for the Ontario-born families, not to mention their greater knowledge of local health resources, their infants and children still died at a greater rate than either those from families born elsewhere in North America or abroad.

A multivariate logistic regression model, summarized in **Table 3.11**, sheds additional light on some of these important issues. The statistical significance of each predictor of childhood mortality is reported, as well as the relative odds (and associated 95% confidence interval) for each variable. The relative odds indicate how much the likelihood of the outcome (having an infant or child death) changes for each unit increase in the independent variable; or in the case of categorical variables, for a change from one category to another. An odds ratio (relative odds) of greater than one indicates an increased probability of the outcome occurring; an odds ratio less than one indicates a decreased likelihood. Generally, the strength of the model is measured by the goodness-of-fit statistic Rho-square (ρ^2), with values between 0.2 and 0.4 generally considered to represent a very good fit of the model (Wrigley 1985). The logistic model estimated here has a Rho-square of 0.10 indicating a poor, but still statistically significant fit. Overall, despite the poor fit of the model, the results suggest that some important predictors of infant and child mortality have been identified, but that other factors, currently unaccounted for, also have an important influence.

In general, the logistic regression model confirms the results of the bivariate analyses presented earlier. Measures of household conditions and structure (ie. fertility, crowding, family size, boarders) and socio-cultural affiliation (ie. religion and nativity) were significant

predictors of childhood mortality (**Table 3.11**). Crowded homes (>0.7 persons per room), for example, were 2.7 times more likely to have an infant or child death than spacious homes. Similarly, for each additional child in the household (under the age of five) the likelihood of having a child death doubled (odds ratio = 2.0). Confirmation of the importance of boarding and lodging to childhood mortality also emerged from the regression model. Those households with one or two boarders were less likely to have a death than households without any, but having three or more boarders was associated with an increased likelihood of death (odds ratio = 1.4). In terms of socio-cultural affiliation, the multivariate results again confirm those from the bivariate analyses. Catholics were 1.4 times more likely to have a death than Protestants, while Jews were one fifth (odd ratio = 0.2) as likely to have a death as Protestants. North American born and British immigrant parents were also less likely to have a child die than Ontario-born parents.

Those variables not entered into the regression model also substantiate results of the bivariate analyses. For instance, maternal employment, housing tenure, and the presence of domestic employees were not entered into the model. Though ethnicity was significantly associated with mortality in the bivariate analysis, in the multivariate analysis it seems that the influence of this variable is largely subsumed under the other socio-cultural variables (ie. religion, nativity and fertility). Most interesting, however, was the absence of any direct

measure of social class (ie. occupation, assessed value) within the regression model. While class, as measured by assessed value, was clearly important to the incidence of childhood mortality, in the multivariate analysis it seems that the underlying influence of class may be accounted for by other measures such as housing conditions (ie. crowding), and socio-cultural factors (ie. Catholics).

The results of both the bivariate and multivariate analyses seem to push us towards the conclusion that there is something about the way that these socio-cultural groups interact and adapt to the local socio-economic and housing environment that contributed to higher levels of childhood mortality. The answer seems to lie with cultural practices. Although the direct linkage between cultural practices and mortality is not always evident, recent literature has indicated that such linkages did exist (Thornton and Olson 1991; Kintner 1987; Sundin 1995). Elevated levels of mortality by socio-cultural groups may be attributed to the cultural practices unique to their culture such as the rate and duration of breastfeeding, the preferred method of artificial feeding once the infant has been weaned, adherence to acceptable levels of personal and domestic hygiene, the preparation of food, as well as important reproductive behaviour expressed through birth-spacing and sibship size. At this stage, no evidence exists to isolate what these specific practices may have been in the Ontario context, nor what their independent significance to the mortality pattern was. What

does seem clear, however, is that certain socio-cultural groups were materially disadvantaged, and when mediated through influences of crowding and specific cultural practices this disadvantage contributed to greater levels of mortality.

This paper has confirmed the findings made elsewhere about the widely divergent mortality patterns, of Catholics and Jews in particular. Each religion had, and still has, its own teachings, beliefs and traditions, which were often passed down from one generation to the next. These beliefs and practices could have had either positive or negative impacts on the mortality of infants and children. For example, we now believe that Jewish families tended to breastfeed their children for a much longer period of time than families of other religious affiliations, and this practice can significantly enhance the survival chances of infants and young children, regardless of the family's material and housing circumstances. Other sanitary and hygienic practices instilled in the practices of the Jewish faith (including hand-washing, and care in food preparation) are now also understood to be advantageous to health, particularly in a generally poor sanitary environment. On the other hand, potentially harmful practices of French-Canadians (almost wholly Catholic) have been documented elsewhere and include comparatively short periods of breastfeeding, and the rapid replacement of previous children who have died (Thornton and Olson, 1991). Others have also documented that Catholics in Europe were slow to adopt new hygiene practices within

the home (Van Poppel 1992). Clearly, therefore, the practices of these socio-cultural groups had a significant impact on the likelihood of their infants and children surviving or not, especially when combined with economic and housing deficiencies.

It is worth noting that without the extremely low mortality of the Jewish population in Toronto, the variation among the socio-cultural groups would have been much less striking. This makes sense, given that the population of Toronto was quite homogenous; more than 90 percent British, and 80 percent Protestant. By excluding the Jewish population, the importance of socio-cultural factors as a determinant of mortality is reduced, and as a result the importance of crowding is heightened further. But the presence of the Jews in the analysis is instructive. In an environment that was uniformly unhealthy, this subset of the population was able to thrive and protect their children like no other. This is all the more remarkable when the living environments of Toronto's Jews are taken into account. Living in the most crowded, and least expensive homes, and within the city's notorious slum, the Jewish were able to remain healthy while their neighbours, of varying ethno-religious origins struggled. At a time when between one and two of every ten births did not survive to their first birthday in Toronto, the success of the Jewish population truly stands out. From this example we can conclude that while crowding and socio-economic circumstances were most certainly important determinants of mortality in Toronto, cultural

practices, such as those exhibited by the Jewish population, could outweigh the adverse effects of overly crowded and poor housing conditions.

This local case study of Toronto in 1901, developed from individual-level death record data, makes a number of important contributions to the historical demography literature. First, it confirms the independent significance of both socio-economic and environmental determinants of infant and child mortality. Of the two, environmental conditions, as measured by the level of internal household crowding is the more important in explaining the mortality pattern. In addition, this paper has shown that socio-cultural factors such as religious affiliation, nativity and ancestral origin were also important determinants of mortality. Again, the results lead us to conclude that cultural practices associated with particular cultural groups, could, in the case of the eastern European Jewish population, allow them to overcome the impact of socio-economic and environmental hardships on infant mortality.

At the same time, the results have highlighted a number of important issues requiring further research. For instance, can the different cultural practices of Jews and Catholics in Toronto, to name the most obvious examples, be ascertained and evaluated as to their direct influence on the incidence of infant and child mortality? Furthermore, what impact, other

than what has been measured here, did differential fertility have on childhood mortality? Finally, the results of the goodness of fit test of the logistic regression model suggest that one or more critical explanatory variables have not yet been accounted for in this analysis. I would suggest that, in some way, the provision of public health and sanitary services was important to the incidence of childhood mortality. By first assessing the intra-urban (neighbourhood) variation of childhood deaths, and second, documenting the availability of sanitary services across the city, we may begin to understand the way that public health influenced individual health risks.

Table 3.1 - Observed and Expected Infant and Child Deaths, by Occupational Class

Occupational Class	Population Households	Expected Deaths	Observed Deaths	O/E Ratio
Self Employed	257	117.4	116	0.988
Owners and Managers	72	26.1	30	1.149
Professionals	135	54.5	45	0.826
White Collar Workers	98	52.9	41	0.775
Skilled/ Semi-skilled Workers	607	305.3	315	1.032
Unskilled Workers	161	69.8	86	1.232
Other	109	23.0	16	0.696
Total:	1439	649	649	

Note: Chi-Square=11.14 (P-Value=0.08)

Table 3.2 - Observed and Expected Infant and Child Deaths, by Assessed Value of Dwelling

Assessed Building Value	Population Households	Expected Deaths	Observed Deaths	O/E Ratio
0- $300	293	151.9	188	1.237
$301- 600	404	225.6	203	0.899
$601-900	264	108.5	100	0.921
> $901	448	158.9	154	0.969
Total:	1409	649	649	

Note: Chi-Square=11.66 (P-Value=0.01)

Table 3.3 - Observed and Expected Infant and Child Deaths, by Level of Household Crowding

No. Persons Per Room	Population Households	Expected Deaths	Observed Deaths	O/E Ratio
< 0.70	695	318.5	178	0.559
0.71-1.00	433	198.5	238	1.199
> 1.01	288	132.0	233	1.765
Total:	1416	649	649	

Note: Chi-Square=147.12 (P-Value=0.00)

Table 3.4 -Observed and Expected Infant and Child Deaths, by Immediate Family Size

No. Immediate Family Members	Population Households	Expected Deaths	Observed Deaths	O/E Ratio
1 - 4	850	383.4	352	0.918
5 - 6	368	165.9	179	1.079
> 7	221	99.7	118	1.184
Total:	1439	649	649	

Note: Chi-Square=6.96 (P-Value=0.03)

Table 3.5 - Observed and Expected Infant and Child Deaths, by Number of Boarders and Lodgers in Household

No. of Boarders & Lodgers	Population Households	Expected Deaths	Observed Deaths	O/E Ratio
0	1170	530	522	0.985
1 - 2	200	91	73	0.802
> 3	62	28	54	1.929
Total:	1432	649	649	

Note: Chi-Square=27.82 (P-Value=0.00)

Table 3.6 - Observed and Expected Infant and Child Deaths, by Housing Tenure and Assessed Value of Dwelling

Housing Tenure	Assessed Value								
	< $300			$301 - 600			> $600		
	Exp. Deaths	Obs. Deaths	O/E Ratio	Exp. Deaths	Obs. Deaths	O/E Ratio	Exp. Deaths	Obs. Deaths	O/E Ratio
Freehold	14.2	31	2.185	36.2	30	0.829	94.8	57	0.602
Tenancy	120.0	157	1.309	148.8	173	1.163	231.2	197	0.852
Total:	134.2	188	1.400	185.0	203	1.097	326	254	0.779

Table 3.7 - Observed and Expected Infant and Child Deaths, by Housing Tenure and Level of Household Crowding

Housing Tenure	Household Crowding					
	< 0.70 persons per room			> 0.71 persons per room		
	Exp. Deaths	Obs. Deaths	O/E Ratio	Exp. Deaths	Obs. Deaths	O/E Ratio
Freehold	83.3	45	0.540	61.6	73	1.185
Tenancy	234.3	133	0.568	265.8	394	1.482
Total:	317.6	178	0.561	327.4	467	1.426

Table 3.8 - Observed and Expected Infant and Child Deaths by Ethnic/Ancestral Origin of Household Head

Ethnic/Ancestral Origin		Population Households	Expected Deaths	Observed Deaths	O/E Ratio
British Isles	England/ Wales	683	316.8	318	1.004
	Ireland -Protestant	277	112.0	96	0.857
	Ireland - Catholic	115	74.4	76	1.022
	Scotland	250	85.9	94	1.094
	Group Total	*1325*	*589.1*	*584*	*0.991*
Eastern Europe	Austria	4	2.3	1	0.435
	Poland	3	2.3	0	- - -
	Russia	20	20.0	5	0.250
	Group Total	*27*	*24.6*	*6*	*0.244*
Western Europe	French	27	13.0	11	0.846
	German	33	10.7	24	2.243
	Italian	6	5.4	15	2.778
	Other Europe	16	4.6	5	1.087
	Group Total	*82*	*33.7*	*55*	*1.632*
Other	(e.g. Africa, NA)	5	1.5	4	2.667
Total:		1439	649	649	

Note: Chi-Square=55.49 (P-Value=0.00) - all ancestral origins
Chi-Square=31.74 (P-Value=0.00) - group totals only

Table 3.9 - Observed and Expected Infant and Child Deaths by Religious Affiliation of Household Head

Religious Affiliation		Population Households	Expected Deaths	Observed Deaths	O/E Ratio
Major Protestant	Church of England	435	203.3	193	0.949
	Methodist	325	125.8	144	1.145
	Presbyterian	305	105.9	113	1.067
	Baptist	87	37.6	33	0.878
Other	Roman Catholic	165	103.6	120	1.158
	Jewish	31	28.4	7	0.247
	Other	91	44.5	39	0.876
Total:		1439	649	649	

Note: Chi-Square=23.60 (P-Value=0.00)

Table 3.10 - Observed and Expected Infant and Child Deaths by Place of Birth/Nativity of Household Head

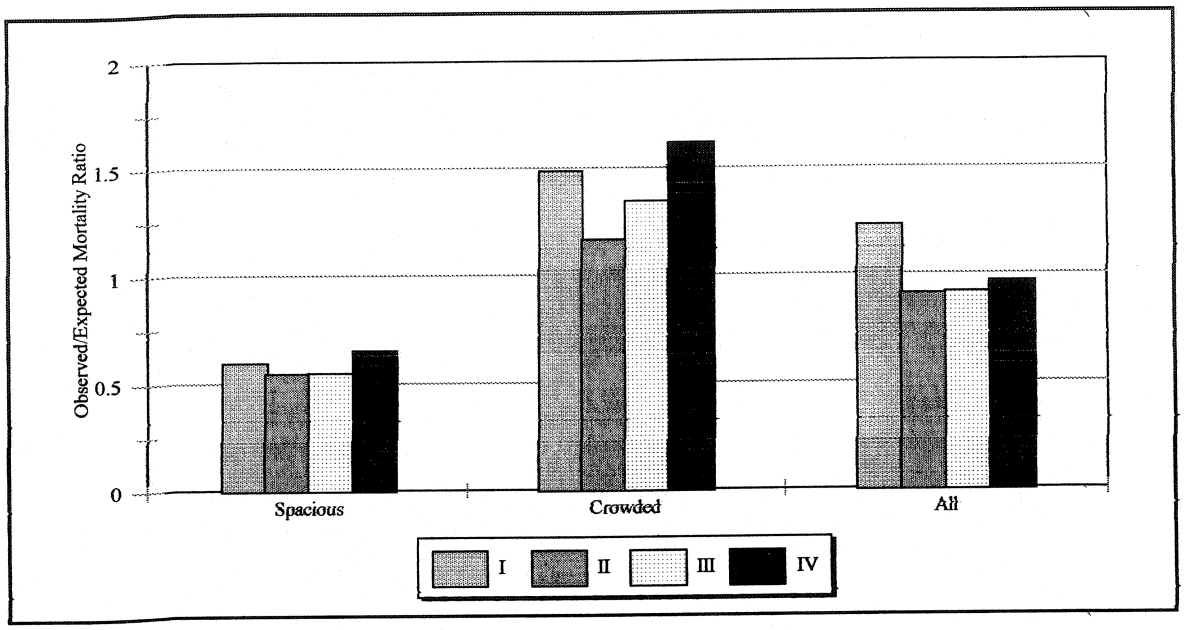
Place of Birth			Population Households	Expected Deaths	Observed Deaths	O/E Ratio
NORTH AMERICA	Canada	Ontario	736	317.6	352	1.108
		Rest of Canada	58	30.7	17	0.554
	USA	USA	43	10.7	18	1.682
EUROPE	British Isles	England/ Wales	354	171.8	145	0.844
		Ireland -Protestant	85	34.5	31	0.899
		Ireland - Catholic	31	21.5	22	1.023
		Scotland	72	20.0	29	1.450
	Eastern Europe	Russia, Poland, Austria	28	26.8	5	0.187
	Western Europe	France, Germany, Italy, etc.	24	9.2	28	3.043
OTHER	Other	Australia, Turkey, India, Malta, etc.	8	6.1	2	0.328
Total:			1439	649	649	

Note: Chi-Square=82.32 (P-Value=0.00)

Table 3.11 - Odds Ratios of Significant Predictors of Childhood Deaths in Logistic Regression

Predictor Variables {Data Type}	No. Cases (%)	Odds Ratio (95% C.I.)	p-value
Crowding {Categorical}	2031		
< 0.70 (persons per room)	861 (42.4)	Reference Category	
> 0.70 (persons per room)	1170 (57.6)	2.657 (2.052-3.440)	0.000
Religion {Categorical}	2031		
Protestant	1587 (78.1)	Reference Category	0.001
Catholic	279 (13.7)	1.413 (1.060-1.885)	0.019
Jewish	37 (1.8)	0.205 (0.073-0.578)	0.003
Other	128 (6.3)	0.941 (0.619-1.431)	0.776
Nativity {Categorical}	2031		
Ontario-born	1067 (52.5)	Reference Category	0.026
N. America	132 (6.5)	0.688 (0.444-1.065)	0.093
Britain	745 (36.7)	0.831 (0.667-1.034)	0.097
Europe	87 (4.3)	1.739 (0.945-3.198)	0.075
Family Size {Categorical}	2031		
0-4 persons	1167 (57.5)	Reference Category	0.000
5-6 persons	533 (26.2)	0.482 (0.364-0.637)	0.000
7 + persons	331 (16.3)	0.425 (0.305-0.591)	0.000
Boarders {Categorical}	2031		
0 boarders	1651 (81.3)	Reference Category	0.028
1-2 boarders	265 (13.1)	0.740 (0.542-1.010)	0.058
3 + boarders	115 (5.7)	1.407 (0.923-2.144)	0.112
Fertility {Continuous}	2031	1.966 (1.730-2.234)	0.000
Model Fit: Rho-Square (ρ^2) = 0.10			

Figure 3.1 - Observed/Expected Ratio of Infant and Child Deaths by Level of Household Crowding and Assessed Value of Dwelling



Notes: Levels of Crowding are, Spacious: <0.70 persons per room; Crowded: >0.70 persons per room. Assessed Value Classes are, I = $0-300, II=$301-600, III=$601-900, IV= >$901.

Figure 3.2 - Median Assessed Value by Religious Affiliation

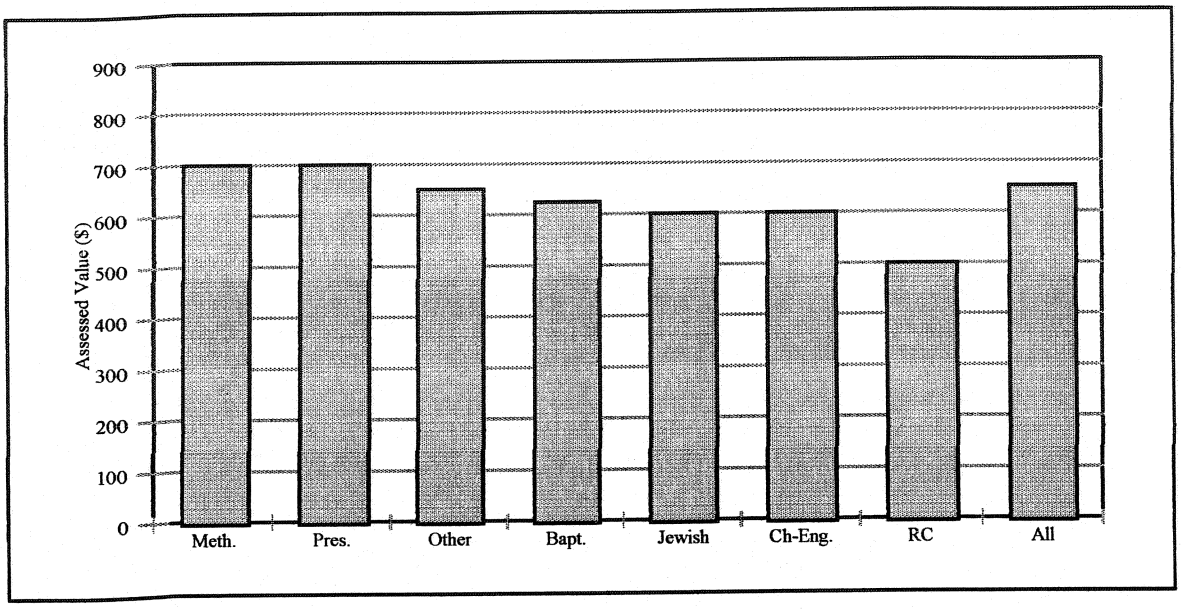


Figure 3.3 - Degree of Household Crowding (Percent Crowded) by Religious Affiliation

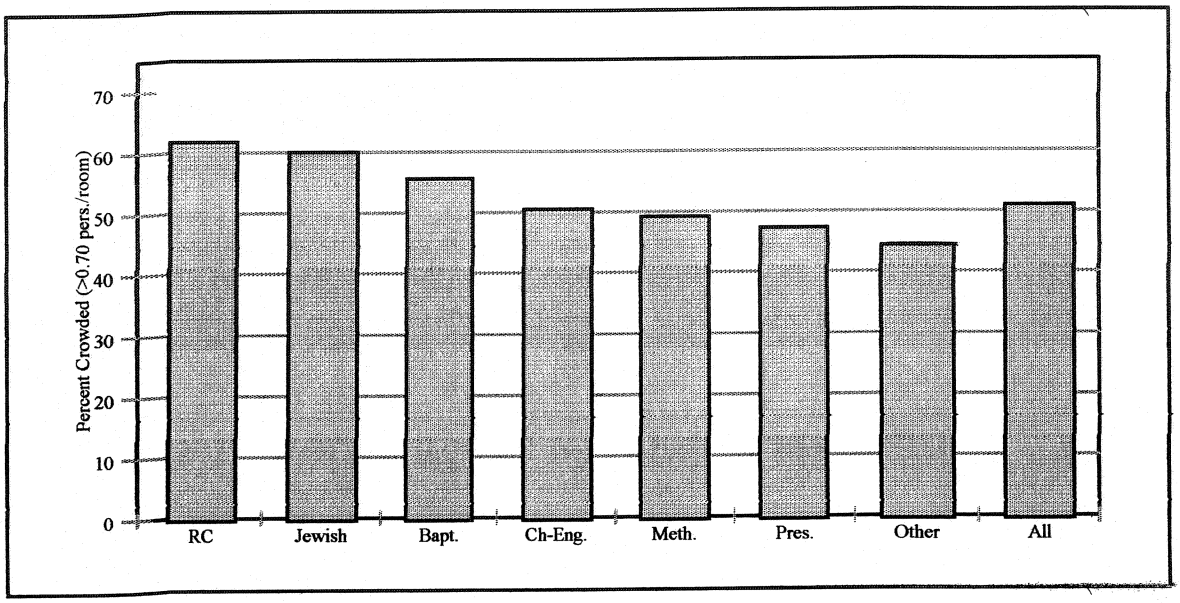


Figure 3.4 - Median Assessed Value by Birthplace/Nativity

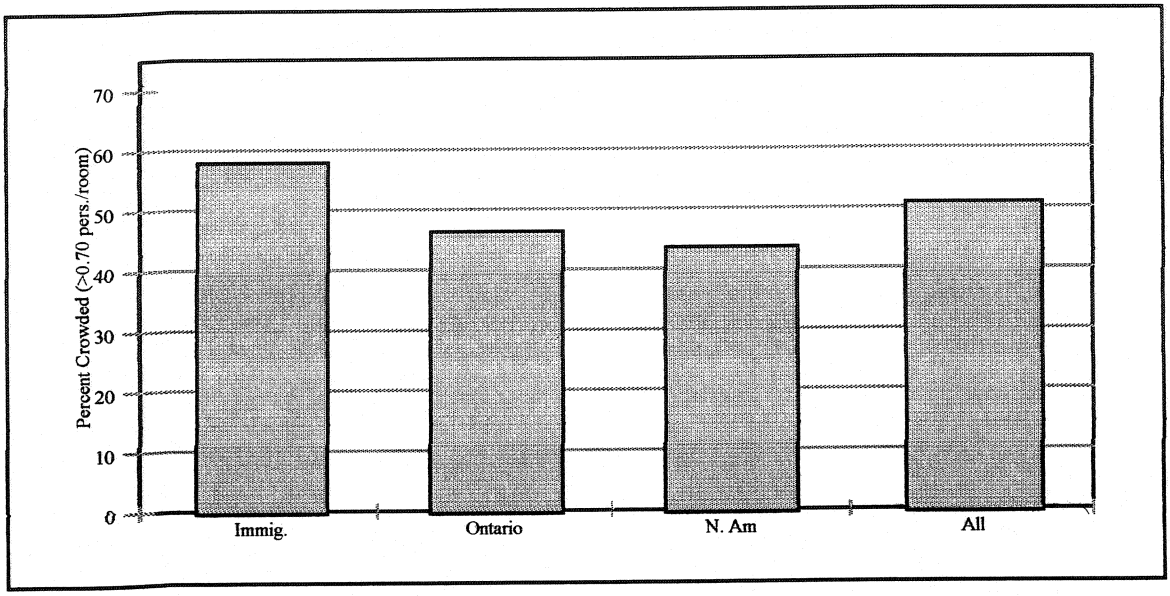
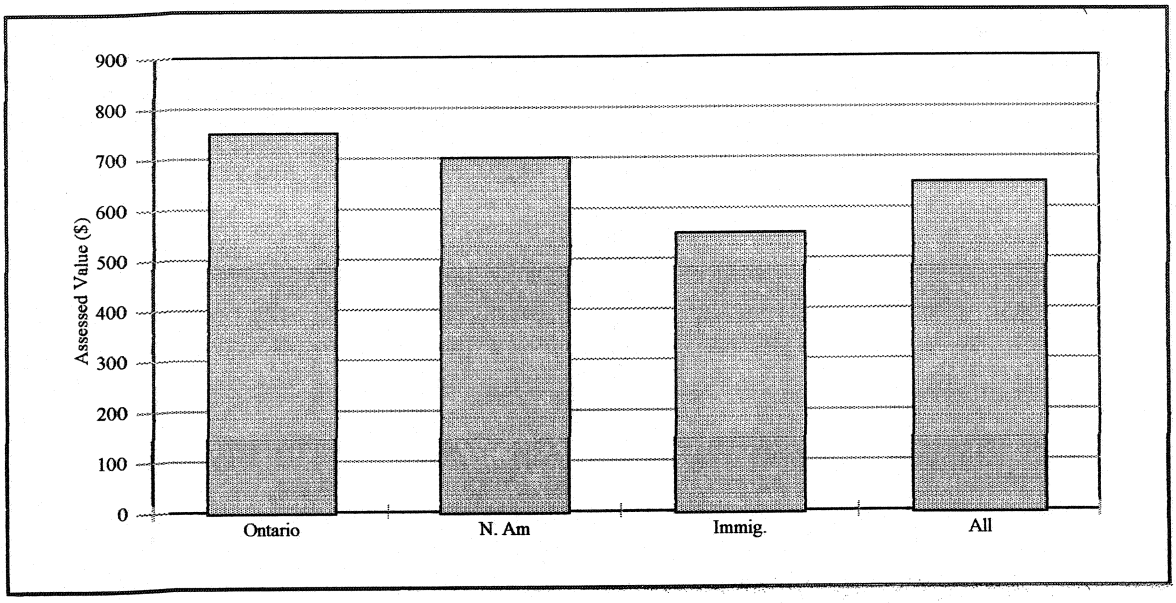


Figure 3.5 - Degree of Household Crowding (Percent Crowded) by Birthplace/Nativity



3.7 - METHODOLOGICAL APPENDIX

The purpose of this methodological appendix is to provide added transparency to the methods used in estimating the observed-expected mortality ratios (OER). Of critical importance to the OER is the fertility factor. This appendix utilises a worked-through example (religious affiliation) to clarify the necessary steps in calculating values for the fertility factors and observed-expected ratios.

For each variable (ie. crowding, occupational class, religion, ancestral origin, etc.) and for each outcome (ie. Catholic, Jewish, Presbyterian, etc.) observed-expected ratios were calculated for the number of infant and child deaths. OER (observed deaths divided by expected deaths) measure the relative mortality risk for particular sub-groups within the population. For example, how did mortality risk vary among different religious groups? If the observed number of deaths are equal to the expected number then the OER equals 1.0. For groups that have an excess of observed over expected deaths, the OER is greater than 1.0.

Of particular importance to the calculation of this ratio is the number of expected deaths. In a simplistic way, we can assume that the expected deaths for each outcome variable would simply represent their proportion of the total population. By such logic, Catholics for example, which account for 11.5 percent of all households, should have a

similar proportion of infant and child deaths. However, families with higher fertility are at greater risk of having one of their children die, and since fertility rates vary between subgroups of the population, it was necessary to control for such fertility differences because they alter the number of expected deaths. For example, in general, Catholic and Jewish families had much higher than average fertility rates. As a result, the expected number of deaths for Catholic and Jewish families should really be much higher (40% and 100% higher respectively) than if fertility differences were not taken into account.

Fertility practices (ie. use of birth control, family limitation, etc.) are often culturally and class-based and, therefore, it was necessary to control for differential fertility rates by socio-cultural and socio-economic background. Without knowing the exact number of births for each subgroup of the population, a method of indirect estimation was used to construct these fertility differentials. For each population subgroup, the average number of surviving children, under the age of five, per woman of child-bearing age was compared to an estimated number of surviving children assuming constant fertility. The resultant 'fertility factor', essentially an observed-expected ratio of surviving children, was used to adjust the number of expected deaths for the OER. Significant fertility differentials were observed, and controlled for, by occupational class, socio-economic standing, ancestral origin, religion, and birthplace.

Below are the operational definitions of the variables used to make these calculations, as well as their specific formulae.

Variables & Method of Calculation:

Population Households (n) → number of population households in outcome variable (i)
→ $CFP*HH_i$

Population Households (%) → percent of population households in outcome variable (i)
→ $CFP*\%_i = (CFP*HH_i) / (\sum_{(i=1 \text{ to } n)} CFP*HH_i)$

Observed Children → number of observed children (aged 0-5) in outcome variable (i)
→ OC_i

Expected Children → number of expected children (aged 0-5) in outcome variable (i)
→ $EC_i = (\sum_{(i=1 \text{ to } n)} OC_i) \times (CFP*\%_i)$

Fertility Factor → ratio of observed to expected children in outcome variable (i)
→ $FF_i = OC_i / EC_i$

Observed Deaths → number of observed deaths in outcome variable (i)
→ OD_i

Expected Deaths → number of expected deaths in outcome variable (i)
→ $ED_i = (\sum_{(i=1 \text{ to } n)} OD_i) \times (CFP*\%_i) \times (FF_i)$

Observed Expected (Death) Ratio → ratio of observed to expected deaths in outcome variable (i)
→ $OER_i = OD_i / ED_i$

Numeric Example: Fertility Factors by Religious Affiliation

Using religious affiliation as an example, the table below (**Table 3.A.1**) shows how these calculations were made. There were 165 Catholic households in the population sample, representing 11.5 percent of the total (see columns $CFP*HH_i$ and $CFP*\%_i$ respectively). Among those Catholic households there were 135 surviving children between the ages of 0 and 5 listed in the Census (OC_i). Without accounting for fertility, we would expect that 11.5 percent of the 846 (97.290) surviving children (between 0 and 5 years) in the entire city would be in Catholic households (EC_i). The ratio of these two numbers (OC_i and EC_i) results in the fertility factor for the outcome variable, in this case Catholic households (FF_i). Such calculations were made for each variable and for each possible outcome in the analysis.

Numeric Example: Observed-Expected Ratios by Religious Affiliation

In a similar way, **Table 3.A.2** shows how the observed-expected mortality ratios were calculated. For ease of interpretation, the first three columns of numbers are taken directly from Table 3.A.1 ($CFP*HH_i$, $CFP*\%_i$ and FF_i). Taking the example of Catholics we see that among the death records there were 120 infant and child deaths in Catholic households (OD_i). If fertility differences were not taken into account, we would expect that 11.5 percent

of the 649 (74.635) infant and child deaths in the city would have occurred among Catholic families. However, Catholic families had much higher than average levels of fertility (FF_i) and so the expected number of deaths were adjusted accordingly. The estimates of expected deaths (ED_i) are the product of the sum of all deaths in the city (649), the outcome variable's proportion of all households (11.5%) and the fertility factor (1.388). The ratio of the observed (OD_i) and expected (ED_i) number of deaths results in the OER. As above, such calculations were made for each variable and for each possible outcome in the analysis.

Table 3.A.1 - Fertility Factors by Religious Affiliation

Religious Affiliation (outcome variable)	CFP^*HH_i	$CFP^*\%_i$	OC_i	EC_i	FF_i
Church of England	435	0.302	265	255.492	1.037
Methodist	325	0.226	164	191.196	0.858
Presbyterian	305	0.212	138	179.352	0.769
Baptist	87	0.061	49	51.606	0.950
Roman Catholic	165	0.115	135	97.290	1.388
Jewish	31	0.022	37	18.612	1.988
Other	91	0.063	58	53.298	1.088
Totals	1439	1.000	846	846	1.000

Table 3.A.2 - Observed-Expected Ratios by Religious Affiliation

Religious Affiliation (outcome variable)	CFP^*HH_i	$CFP^*\%_i$	FF_i	OD_i	ED_i	OER_i
Church of England	435	0.302	1.037	193	203.3	0.949
Methodist	325	0.226	0.858	144	125.8	1.145
Presbyterian	305	0.212	0.769	113	105.9	1.067
Baptist	87	0.061	0.950	33	37.6	0.878
Roman Catholic	165	0.115	1.388	120	103.6	1.158
Jewish	31	0.022	1.988	7	28.4	0.247
Other	91	0.063	1.088	39	44.5	0.876
Totals	1439	1.000	1.000	649	649	1.000

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CHAPTER 4: THE SOCIAL GEOGRAPHY OF CHILDHOOD MORTALITY, TORONTO, 1901

4.1 - INTRODUCTION

Through nineteenth century accounts, we have become accustomed to terms such as slums and 'hives of sickness' to describe crowded and poor inner-city neighbourhoods. We assume that ill-health was commonplace within them. In truth, such beliefs are poorly grounded. The absence of historical studies exploring the geography of mortality at the neighbourhood scale means that we do not really know which neighbourhoods were healthy and which were not. Neither do we know what made certain neighbourhoods more unhealthy than others. The purpose of this paper is to begin to fill this gap.

In part, the lack of research on historical urban mortality stems from limitations in the availability and quality of local death registration data. Researchers have sometimes had to rely on aggregate-level data for entire urban areas or, more often, regions and countries, and therefore, intra-urban variations of mortality have been largely neglected. This is especially true in North America, where mortality records remained unreliable into the twentieth century. Focussing on the city of Toronto, Ontario, in 1901, this paper uses individual death records to document and partially explain the geography of childhood mortality at the neighbourhood scale.

Deaths of infants and children are the most important to the overall mortality distribution and most accurately reflect the quality of the living environment. For example, at the turn of the twentieth century about one quarter of all deaths in the province of Ontario were of children less than five years of age, and three quarters of these were infants in their first year of life (Registrar General, 1903). Infant and child mortality rates are often used as indicators of living standards, and to compare the relative healthfulness of communities.[1] At the end of the nineteenth century, of the 40 North American cities with a population greater than 100 000, infant mortality rates (IMR) ranged from 95 (deaths in the first year per 1000 live births) in Minneapolis to about 285 in Montreal, with an average of 170 (Meckel, 1990; U.S. Census Bureau, 1901). Among this group of cities, Toronto was about average in terms of population at 208 000 (ranked 18th), and infant mortality (167). Compared to North American urban places of all sizes, however, Toronto was considered large, and relatively unhealthy, as measured by its infant mortality rate (McInnis, 2000b). Community health can be judged by levels of infant and child mortality, thus we should also be capable of assessing neighbourhoods by the same measures, although examples of neighbourhood studies are currently lacking. Utilising 1901 Toronto as a case study, and individual-level cross-sectional data aggregated to the neighbourhood scale, this paper shows that, contrary to prevailing assumptions (section 1) unhealthy districts were not confined to

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1 A generally accepted point within the literature, see, for example, Beaver, 1973; Condran and Cheney, 1982; Gagan, 1989; Haines, 1995; Mooney, 1994; and Thornton and Olson, 1991.

mortality rates in urban registration districts were as much as double those of rural ones (Bairoch, 1988; Lee, 1991; Williams and Galley, 1995; Woods et al, 1988). In North America, though less thoroughly documented, a similar contrast existed. In 1900, urban mortality rates for infants (aged less than one) in the highly urbanised U.S. north-east were fifty percent higher than in rural areas; the urban-rural differential was almost one hundred percent for children aged one to four (Condran and Crimmins, 1980). Much the same was true in Canada too (McInnis, 2000a and 2000b; Mercier, 2003a). Among North American cities, some of the highest infant mortality rates in the industrialising world were reported for cities in Quebec such as Montreal and Quebec City while, in Ontario, the situation in Toronto and Hamilton was more in line with cities in the U.S. and Britain (McInnis, 1990; Meckel, 1990). Everywhere, the generally poor living conditions within cities were of the utmost importance to turn-of-the-century mortality.

It is reasonable to suppose that variations in living conditions, these often being associated with social patterns within cities, also shaped the geography of mortality within urban areas. Geographers and historians have documented many aspects of the social geography of nineteenth and early twentieth century North American cities, including living conditions. Much attention has been drawn to the way that the processes of industrialisation and urbanisation altered the residential landscape of the city, as the cities evolved from a

mercantile form to an industrial one (Knox, 1994). North American cities up to the mid-nineteenth century were compact since the population was dependant on foot and horse power. As a result, up to about 1880, even the largest cities were small, and compact enough that people could walk between home and work (Warner, 1978). A consequence of this dense urban form was that, in general, cities were not neatly divided into residential, commercial, or industrial zones, nor were people particularly segregated by class or ethnicity (Carter, 1983; Goheen, 1970). As cities felt the full force of industrialisation, however, their social geography changed. While the size of cities, in both population and extent, grew rapidly in the closing decades of the twentieth century, the internal organisation changed as well (Warner, 1972). Commercial activities became centralised, and in need of more land as industrial technology changed many industries decentralised to the suburban fringe, commonly along transportation corridors (Lewis, 2000). While the geography of economic activity changed, so too did the residential landscape. Many of the affluent sought refuge from the ravages of the industrial city by moving to suburban enclaves (Jackson, 1985). Many of the working-class also moved out of the old mercantile core, in search of suburban industrial employment (Harris, 1996). Most writers have argued, however, that the most important change to cities in the late nineteenth century was the emergence of slum and tenement districts (Day, 1999; Hall, 1997; Mumford, 1961; Ward, 1971). Millions of European immigrants flooded into North American cities and were forced to live in

increasingly crowded and insanitary conditions in converted tenements in slum districts close to the city's centre (Day, 1999; Ward, 1971). By the turn of the twentieth century, at the point that urban reformers calls for change reached their peak, North American cities were clearly demarcated by central poverty and suburban affluence, though exceptions existed in both cases (Goheen, 1970).

It is likely that these local variations in living conditions caused mortality rates to vary within cities, from neighbourhood to neighbourhood, but little is known about this.[2] Prior to the twentieth century, few mortality data were published at the scale of neighbourhoods, or even city wards, many of which are buried in local board of health reports that, with the exception of occasional local histories, have not been sufficiently mined (Harris and Mercier, forthcoming). Unpublished data, on the other hand, are difficult to access, and for much of the nineteenth century are unreliable. The challenges in collecting, and the oftentimes inaccessibility of, individual-level data has limited the number of studies that take a micro-level perspective to the study of urban mortality (Leavitt, 1982; Thornton and Olson, 2001). What has emerged from this limited literature, however, is an

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2 While environmental and public health historians have begun to take up the challenge of systematically documenting the history of the provision of urban sanitary services such as sewers and water supply (two important components of living conditions) no such comprehensive documentation has yet been undertaken for Toronto, or indeed Canada (for the United States, see, Melosi, 2000). However, Brace (1995) has documented the development of main sewer lines in Toronto, and Riendeau (1984) has explored the issue of urban services more generally.

appreciation for the importance of both socio-economic and socio-cultural factors, as well as local environmental conditions.

Environmental conditions, especially the level of sanitation services, and the quality and condition of housing, greatly influenced urban mortality rates. Often used as surrogate measures for environmental conditions, population density and internal household crowding, have both been found to be positively associated with the spatial variation of, and absolute levels of, infant mortality rates in cities (Higgs and Booth, 1979). In Milwaukee, for instance, Leavitt (1982) found that at the municipal ward-level, congested housing was the single most important determinant of general mortality rates. A contemporary study of eight U.S. cities in the 1910s and 1920s, summarised by Woodbury (1925), concluded that, even after controlling for the father's occupation and income, household crowding elevated the level of infant mortality by a factor of two. The relationship between mortality and environmental conditions, whether measured by urban-rural differences, population density, or internal household crowding is consistent and clear; when greater numbers of people congregate in close proximity, especially in a poor sanitary environment, the risk of infectious diseases spreading is high, and mortality rates of infants and children in particular soar (Gagan, 1989; Mercier, 2003b; Woods et al, 1988).

Socio-economic factors, most especially social class, as measured by occupation, income or property values, have also been clearly associated with levels of mortality at the intra-urban scale. Most prominent among these factors, especially for Britain, is social class. In nineteenth century Sheffield, for example, both environmental conditions and social class exerted significant and independent effects on infant mortality, and the direction of the relationship with class was in the expected direction (Williams, 1992). Those in the highest occupational class, regardless of their local sanitary environment, had lower infant mortality rates than those further down the occupational hierarchy. Similar relationships have been observed through aggregate-level analysis for elsewhere in Britain (Haines, 1995; Woods et al, 1988). For Adelaide, Australia, Smith and Frost (1994) showed that while at the aggregate-level low density housing was associated with lower mortality, at the individual-level the most important consideration was the economic conditions of the individual family. The value of one's home, as a proxy for wealth and income, has been shown to be an accurate and robust measure of economic class in nineteenth and twentieth century Toronto (Goheen, 1970; Harris, 1996; Hiebert, 1995). In turn of the century Ottawa (Mercier and Boone, 2002) and Toronto (Mercier, 2003b) strong inverse relationships existed between the assessed value of the family home and the incidence of childhood mortality.

Levels of mortality, especially that of infants, have also been associated with socio-

cultural differences, such as religious affiliation, ethnic or ancestral origin, and nativity of parents. Most prominent among these cultural differences is the mortality differential between French-Canadians on the one hand, and Jews on the other. In Montreal (Thornton and Olson, 1991; 1997; 2001), Ottawa (Mercier and Boone, 2002), and the eastern U.S. (Woodbury, 1925) infant mortality rates for French-Canadians were significantly higher than for any other socio-cultural group, and the differentials remained even after social class and environmental conditions were accounted for. In the U.S., infant mortality rates of Jews were significantly lower than those of any other socio-cultural group, even after other possible confounding factors were controlled (Condran and Kramarow, 1991). In Toronto, despite comparatively small populations of Jews and Catholics, an analysis of individual death records has shown the same patterns: low mortality among Jews, and high among Catholics (Mercier, 2003b). Immigrant status was also found to correlate with mortality levels at the intra-urban scale. In Milwaukee, concentrations of recent immigrants were associated with elevated mortality, though the problem of disentangling the immigrants from their overly crowded conditions proved difficult because of the aggregate ward-level data available there (Leavitt, 1982).

While historical demographers are far from reaching a consensus on the relative contributions of these factors to the levels of mortality overall, each can plausibly be

associated with intra-urban variations of mortality. Emerging from this literature, therefore, is the significant and independent importance of economic, cultural and environmental circumstances on infant and child mortality levels. The way these factors vary within the urban setting, and how those variations correlate with levels of childhood mortality, is what is of most interest in this paper.

4.3 - THE LOCAL CONTEXT

Toronto, situated on a gently sloping shoreline and influenced by a continental climate with hot, and sometimes humid, summers and long, cold, but relatively dry winters, was not subject to major problems of drainage, though the winters forced people to spend significant amounts of time indoors, hence making crowding a potential issue. Nonetheless, Toronto was not subject to any particular physical geographical influences that made it an unusually unhealthy place to live. A naturally protected harbour provided an ideal setting for the initial trading and military outpost, and later bustling commercial and industrial city. Founded in the late eighteenth century, Toronto was incorporated in 1832, and by 1901 had reached a population of over 200 000 (Careless, 1984). Toronto's initial growth was tied to its role as the seat of government for the province of Ontario, but its strategic location as an access point to the Upper Great Lakes and the U.S. mid-west also contributed to its

growth in the nineteenth century. The city's economy was driven, in varying proportions over time, by finance (banking and insurance), commerce (wholesale and retail trade) and industry (iron, woodworking and textiles) that thrived on its role as the capital of Anglophone Canada (Careless, 1984).

The population of Toronto grew in waves in the nineteenth century, but never in so spectacular a fashion that it completely overwhelmed the available housing stock or municipal infrastructure. The largest rates of growth occurred in the early nineteenth century, especially between 1821-1851 when the city's population increased by 19 times, from less than two thousand to 30 775. The largest absolute population surge, however, occurred in the 1880s when 95 000 immigrants swelled the city's population. Then, slowed by a global depression, the rate of growth of Toronto slowed to a trickle in the 1890s when the population grew by only 15%, the lowest rate in the city's history (Careless, 1984). From the outset Toronto was largely a community established by British immigrants, but famine Irish in the 1840s and 1850s altered the social composition of the city by adding a sizeable Catholic population (Careless, 1984). Continued British immigration in the following decades meant that, by 1901 greater than ninety percent of the population was of British or Irish ancestry, eighty percent of which were Protestant. Aside from an Irish Catholic population which accounted for eight percent of the total, the city also contained very small

minority groups of French (2%), German (3%), Dutch (0.5%), Italian (0.5%) and eastern European Jewish (2%) ancestry.

Toronto's infant mortality rate (IMR) in 1901 (167/1000 births), was average by Canadian urban standards. IMRs were published for 24 Ontario cities, with an average of 162, and ranging from 74 (Owen Sound) to 292 for Ottawa (Registrar General, 1903). Data for other Canadian cities are sparse, but according to McInnis (2000b, p.568) Francophone Canadians had notably high infant mortality rates, and in Montreal and Quebec City, the two largest Francophone cities, one in four infants died in their first year, even well into the twentieth century when rates had begun to decline. Average in level, Toronto's mortality regime was also typical of cities of the period (Sawchuk and Burke, 2000; Thornton and Olson, 2001; Williams, 1992; Woods and Shelton, 1997). Children were most likely to die in the first six months of life and the rate of death then declined. Deaths occurring in the first year, especially the latter half, were most likely to occur in the summer months when gastro-intestinal pathogens were most prevalent due to high temperatures, and were easily spread through contaminated drinking-water supplies. Once past the first year, children in Toronto, like elsewhere, were most likely to die from respiratory infections. The preponderance of respiratory deaths among children, coupled with a strong fall-winter seasonal pattern, is consistent with the greater importance of housing conditions, especially

crowding, on survival chances of young children.

As Toronto made the transition from a commercial city in the mid-nineteenth century, to an industrial one at the end of the century, the social landscape changed. In 1870, the point at about which the city began to make this transition, the residential landscape was not strongly marked by segregation either in terms of class or culture (Goheen, 1970). While there were areas of deprivation and affluence, and Catholics were moderately clustered in the city's eastern half, most residential areas were socially mixed. As the city evolved from a mercantile pedestrian city to one dominated by industry and the streetcar, its residential landscape, like other North American cities of the period, was radically altered. Industrialisation and urbanisation created a residential pattern by 1900 determined strongly by occupational class (Goheen, 1970). Middle- and upper-class residential areas had formed in several areas of the city, including Rosedale, the Annex, and Parkdale (**Figure 4.1**), while working-class areas marked by dilapidated housing, inadequate sanitary services, and poverty existed both in the city's central core and on the urban periphery. At the same time, residential patterns did reflect cultural affiliation, though to a lesser degree than occupation. Goheen's analysis confirmed the clustering of recent non-British immigrants in the Ward, and the Catholic population into three distinct areas of the city, Corktown, Niagara, and Brockton Village. Goheen's analysis, however, suggests that through the process of

industrial and urban growth, the city's population was sifted and sorted mostly by occupational class, such that by the turn of the century the city's residential landscape was best defined by class not culture.

By the twentieth century, Toronto's transition to an industrial economy was assured. Following a global economic depression in the 1890s, renewed economic growth in the new century was driven exclusively by industrial production (Piva, 1979). Beginning in the late nineteenth century, as industries grew, and demand for space increased, Toronto's industries decentralised and created new areas of economic production primarily to the west and north-west. As industries decentralised, so too did the city's population, both middle-class and working-class (Harris, 1996). Furthermore, following changes to national immigration policy in 1896, many of the immigrants that arrived in eastern and central Canadian cities such as Toronto were from new sources such as southern and eastern Europe (Hiebert, 1995). By 1901 this change had only just begun to create new social cleavages between Catholics, Jews, and Protestants and, as Piva (1979) asserts, despite the important contributions that these ethnic and religious characteristics had on the life of the city, the most important social divisions continued along class lines.

The implications of these class divisions were most visible in the places people lived.

While some of the upper- and middle-class chose to escape the hardships, pollution and congestion of the industrial city, by moving to affluent suburban neighbourhoods, some chose to remain more centralised around Jarvis Street and near the University of Toronto. Those among the working-class were not so fortunate to have such residential options. Housing and environmental conditions in much of the central residential districts were poor to say the least. In 1911, the city's medical health officer Charles Hastings declared that the city had three slums (the Ward, Corktown, and Niagara) and that privies and cesspools, shack housing, and extreme poverty and crowding predominated in these areas (Hastings, 1911). A year later, it was estimated that the city had 13 000 privies, servicing a population of between 50 000-100 000, though not all were in the notorious slums (MacDougall, 1990). A substantial increase in immigrant populations in the first decade of the twentieth century, mainly in the city's central core, likely contributed to these slum conditions, but it is likely that conditions had hardly been any better in 1901. While housing conditions and rates of crowding were high in the central core, not all of the city's working class lived there. Some working-class families purchased inexpensive unserviced land on the urban periphery and built, over a number of years, their own suburban home (Harris, 1996). Without sanitary services, and often quite small, these homes were fraught with their own problems, not the least of which was health.

Emerging from this literature, therefore, is an understanding that in 1901 the social geography of Toronto was determined mainly by class, and that there was a correlation between class, housing and corresponding environmental conditions. While such a conclusion is indicated by existing studies, it is not fully established. The studies of the social geography of Toronto by Harris (1996) and Piva (1979) were not primarily concerned with 1901 and Goheen's analysis (1970), based on smoothed data surfaces is useful in identifying general patterns, but less helpful in determining local circumstances. Therefore, there is a need to document the social geography of 1901 Toronto further before analysing the geography of mortality. In this paper, I report spatial patterns on each of the three dimensions (class, culture and housing), using specific variables that were important in determining mortality at the scale of the individual household.

4.4 - DATA SOURCES AND METHODS

Of necessity, most mortality research has relied on aggregate-level data. Exceptions include studies of nineteenth century Montreal (Thornton and Olson, 1991; 1997; 2001), Ottawa (Mercier and Boone, 2002), Toronto (Mercier 2003b), Adelaide (Smith and Frost, 1994), and Sheffield, England (Williams, 1992). Data for specific individuals, while more time-consuming to collect and to analyse, is usually preferable because they offer greater

analytical precision, and avoid problems of ecological fallacy. The objectives of this paper are to document the geographical patterns of childhood mortality (under the age of five), and to undertake a preliminary analysis of their causes. For such purposes individual-level data is much superior. Several archival sources of data for 1901 were utilised including the provincial registry of births, marriages and deaths, the manuscript Census of Canada, the city tax assessment rolls for Toronto, as well as city directories and fire insurance plans. From these varied sources, two directly comparable individual-level databases were constructed. The first, a five percent random sample of Toronto's households, makes it possible to document the social, demographic, economic, and environmental circumstances of the general population, while the second, a complete enumeration of infant and child deaths in the city, contains the same information for those families that had a death in Toronto in 1901.[3]

In order to assess the importance of specific factors to the incidence of infant and child deaths, it was necessary to construct a database for a sample of the general population. The Canadian Families Project (CFP) database, now widely available, is a stratified five

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3 For a more thorough treatment of how the databases were constructed see, Mercier, 2003b.

percent national sample of the 1901 Canadian Census.[4] The CFP sample data for Toronto, supplemented with tax assessment information gathered by the author, became the control population for the analysis. The sample is spatially, and otherwise, representative of Toronto's general population (Buck et al, 2000; Dillon, 2000; Ornstein, 2000).[5] The author's larger project, of which this paper is just one facet, represents the first opportunity to use 1901 manuscript Census data for analyses of the population of Toronto.

In 1901, accurate and complete death registrations coincided, for the first time, with a national Census (Emery, 1993). My complete enumeration of the death registry resulted in 698 infant deaths and 237 child deaths being recorded. From the death records, information was collected for each of the 935 infants and children including, name, age at death, religion, father's name, doctor's name, place of residence, as well as date and cause of death. Utilising the methods of record-linkage, each of the deaths were linked to the 1901 manuscript Census of Canada and the 1901 municipal tax assessment rolls in order to reconstruct the social, economic and housing conditions in which the infant had lived and

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4 I would like to graciously acknowledge the members of the Canadian Families Project, and especially its director, Eric Sager, for providing me with their sample data for the city of Toronto, ahead of its public release.

5 In terms of various measures of the general population such as religious affiliation, ancestral origin, age structure, immigrant status, etc., the control population is a suitably representative five percent sample. For more information on the CFP sample see the special issue of Historical Methods (2000).

died. In some cases the information recorded on the death record was insufficient to permit a successful linkage with the Census, and so additional sources such as the annual city directories (1897-1903) and the 1899 fire insurance atlas were consulted. All told, 661 deaths (481 infants and 180 children) were eventually traced to the Census and Assessment rolls; a success rate of 71% which is comparable with similar record-linkage studies of the same period (Williams, 1992).[6]

While the data used for analysis are individual-level, in order to undertake meaningful analysis of the geography of mortality it was necessary to aggregate to useful areal units. A number of possibilities were considered including political wards (6), tax assessment divisions (18), and Census districts (5) and sub-districts (16). In each case the number of units was too few, and the size of each was too large to allow for meaningful interpretation. An additional unit of spatial measurement considered was the Census polling sub-divisions (enumeration areas). Generally encompassing a few square blocks and, on average, a population of about 700, these sub-divisions were too small and of inconsistent size. In 1901, Toronto was comprised of 298 such sub-divisions, ranging in population from 17 to 1786. Using the 5 percent sample-rate for the control population, this resulted in a

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6 The majority of deaths that remained untraceable (95) were infants that died in public or charitable institutions, and for whom no supporting data exist. Excluding these, fully four-fifths of the infant and child deaths were eventually traced to the Census and assessment rolls.

range of sampled households per sub-division of zero to 18. Clearly, the existing available areal units, whether they were developed for the Census or municipal electoral or taxation purposes were either too small or too large for useful analysis.

The solution involved creating specially designed areal units by combining the 298 Census polling sub-divisions into 44 'neighbourhood units' (**Figure 4.1**). These neighbourhood units, generally comprised of between five and ten sub-divisions, were developed with the intent of each having a minimum of 30 sampled households. However, it was also deemed important to maintain the integrity of certain neighbourhoods by making use of physical boundaries, such as major streets, rail lines, and physical features of the landscape. As a result, some neighbourhood units consist of fewer than 30 households. For instance, in the 1901 sample Rosedale, a clearly demarcated wealthy suburban neighbourhood at the northern extent of the city, consists of only 21 households, while the average across the city is 47.

The number of births in Toronto in 1901 (4445), as well as the age structure of the population, are unknown at any spatial scale other than for the city as a whole. True infant or child mortality rates could not be calculated for the neighbourhood units used for analysis. In their stead, observed-expected mortality ratios were calculated by comparing observed

numbers of infant and child deaths with an expected number. In order to create accurate estimates of the number of expected deaths, it was first necessary to determine the 'at risk' population. In so doing, both the child death and control population databases were controlled for maternal age (15-49 years). The resultant death database consisted of 649 households, and the control population 1439 households. It was also necessary to control for differential levels of fertility because families with higher rates of fertility were at greater risk of having one of their children die. Without the numbers of births for each subgroup of the population, or neighbourhood, a method of indirect estimation was used to construct fertility differentials. For each neighbourhood, the average number of surviving children, under the age of five, per woman of child-bearing age was compared to an estimated number of surviving children assuming constant fertility. The resultant 'fertility factor', essentially an observed-expected ratio of surviving children, was used to adjust the number of expected deaths. Fertility levels varied significantly across the city, and no discernable pattern emerged.[7] Neighbourhoods of high and low fertility were found in both inner-city and suburban locations and high and low values appeared in locations characterised by both affluence and poverty.

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7 Chi-Calc=60.643 (p-value 0.04).

4.5 - THE SOCIAL GEOGRAPHY OF TORONTO, 1901

Class, religion and housing conditions not only framed the social geography of Toronto, but they were also significant determinants of childhood mortality. In results reported elsewhere, I have shown that specific measures of each of these concepts were associated, at the individual scale, with infant and child mortality in 1901 Toronto (Mercier, 2003b). In terms of class, the best available measure was assessed value. We might have expected a continuous relationship, but in fact there was a clear threshold. Those families residing in homes assessed at less than $300 had, on average, 24% more deaths than otherwise expected, while those above the threshold had lower than expected mortality. Just over one fifth (20.8%) of Toronto's homes were assessed below $300, most of which were small (less than five rooms) and were of wood frame construction. A threshold was also found for levels of household crowding, a measure of the local environmental conditions in which the family lived. In general, homes are considered crowded when more than one person shares a room (Lepore, 1998; Sager, 1998). This, however, is an arbitrary figure. My individual-level analysis of 1901 Toronto found that in terms of impact on childhood health, a real threshold occurred at 0.70 persons per room. With a level of crowding greater than this, the risk of infant or child deaths was 43 percent higher than expected. Socio-cultural factors were found to be important to the incidence of childhood mortality as well. It did

not matter whether the measure of socio-cultural difference was the family's ancestry, their religious affiliation or the nativity of the parents, in each case there was a significant association between socio-cultural affiliation and infant and child mortality. The most influential factor, however, was the religious affiliation of the family, with adherence to Judaism associated with low mortality levels, and Catholicism associated with high mortality. Because of their association with childhood mortality at the household scale, therefore, three variables are used to describe the social geography of Toronto in 1901: the proportion of households assessed below $300, the proportion of dwellings exceeding 0.70 persons per room, and the proportion of Catholic families.

These three variables indicate that the social geography of Toronto at the turn of the century was more heavily marked by cultural differences than Goheen has suggested. Concluding his analysis of residential patterns of Toronto in 1899, Goheen stated that "once again, no religious groups are systematically segregated within the city but all economic classes possess highly individual distributions based on principles of strict segregation"(1970, p.218). In order to establish the level of social segregation in 1901, the index of segregation was used.[8] A simple and commonly used measure of residential

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8 $S = \sum|X_i-Y_i| / 2$, where i=1 to N, and where X_i is the percentage of a particular subgroup living in areal unit i, and where Y_i is the percentage of the rest of the population living in area unit i. The index of segregation (S) is commonly mistaken for the index of dissimilarity (D) which measures the differential residential patterns of two (or more) social groups.

segregation, the index measures the spatial clustering of a particular population subgroup (ie. Catholics, Irish) in relation to the rest of the population (Cadwallader, 1996). Index values range from 0-100, where a value of 0 indicates that the subgroup is distributed in exactly the same pattern as the rest of the population (ie. not segregated at all) and a score of 100 means that the group is entirely clustered into one area (ie. perfectly segregated). In terms of this measure, it is clear that at least the Jewish community was very highly segregated. Although their numbers were small, the Jewish population was the most segregated of any social group with a very high index value of 84.5, indicating that almost all of the Jews were located in a select few neighbourhoods (ie. the Ward). Catholics, larger in number and perhaps more diverse in ethnic origin, were also fairly segregated (32.8), though much less so than Jews. By way of contrast, segregation by social class, although perhaps on the increase, was somewhat lower. Using the measure of $300, for example, as defining the location of lower-income households, a moderate value of 30.3 was obtained indicating some clustering of lower-income homes in particular neighbourhoods, but, at the same time, there were at least some low assessed homes in almost all neighbourhoods. An even lower index value for crowded homes (23.4) suggests that crowding was not restricted to specific areas, and was in fact, a problem across the city.

While individual-level analysis has confirmed the significance of these variables as

determinants of infant and child mortality, their spatial variability within the city remains to be shown. There are a number of measures which allow for the spatial variation of attributes to be examined. A common and simple measure is the location quotient (LQ).[9] This shows how different a neighbourhood is, in terms of a specific attribute, relative to the overall city. An LQ of 1.0 means that the neighbourhood has the same relative value, for the attribute being considered, as is found across the entire city. An LQ greater than 1.0 indicates an over-representation of the attribute in the neighbourhood, and therefore, a relative concentration. Utilising location quotients, **Figures 4.2 - 4.4** map the spatial variability of assessed values, crowding and religion respectively for the 44 residential neighbourhoods in Toronto.

While one measure of the relative level of affluence in a neighbourhood is the mean or median assessed property value of homes, what was more important to the incidence of mortality was the proportion of homes assessed at less than $300. While one fifth of all homes were assessed below this threshold, the proportion varied greatly between neighbourhoods. For instance, two neighbourhoods (the Annex and Parkdale) had no homes assessed below $300 (LQ = 0), while as many as half the homes in Corktown were assessed below this threshold (LQ = 2.4). These neighbourhoods represent the extremes (**Figure 4.2**).

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9 LQ = {% in category k in neighbourhood i} / {% in category k over all neighbourhoods}.

In all, nine neighbourhoods, mostly located in the north-central and western parts of the city, had location quotients less than 0.5. At the other end of the range, three neighbourhoods, including the aforementioned Corktown, as well as Niagara and King West, had location quotients greater than 2.0, meaning that their proportion of low assessed homes was more than double the city average. In general, neighbourhoods with low location quotients, such as Parkdale, the Annex, Rosedale, and Jarvis Street were the more affluent and occupationally segregated ones identified by Goheen (1970), while the high LQ neighbourhoods were those Goheen associated with high rates of poverty, as measured by proportions of rented dwellings.

Housing conditions, as measured by levels of household crowding, had a more narrow range of variation across neighbourhoods than assessed value. Overall, almost exactly half (51%) of all households in Toronto in 1901 had greater than 0.70 persons per room. While this proportion did vary between neighbourhoods, the variation was less than that observed for assessed value (**Figure 4.3**). The Annex, again, had the lowest location quotient for crowding at 0.3. A cluster of the most crowded homes existed in the group of neighbourhoods located at the mouth of the Don River including, Corktown (1.9), St Lawrence (1.3) and southern Cabbagetown (1.4). Crowding however, was not simply associated with inner-city conditions. In suburban fringe areas to the east (Danforth) and

north-west (Dovercourt) over seventy percent of homes (LQ = 1.5 and 1.4 respectively) were above this crowded threshold, while in the two neighbourhoods comprising the Ward, one of the city's notorious slums, crowding was only slightly above the city average (1.1 and 1.3 respectively).

The most striking social geographic patterns emerge for the socio-cultural factor. Among the three variable considered here, the spatial variation is greatest for the proportion of neighbourhood households belonging to the Catholic church. In a distinctly Protestant community, where over eighty percent of families belonged to one of the Protestant churches, Catholics, along with Jews, represented a small minority, but were distinct in their residential patterns (**Figure 4.4**). The proportion of Catholics in the general population was 11.5%, and this varied from some neighbourhoods with none (Dufferin, Sully and Palmerston) to others with upwards of forty percent (Corktown). Location quotients, therefore, ranged from 0 to 3.4, or nearly three and a half times the city average. Concentrations of Catholics existed in three distinctly industrial working-class neighbourhoods; the lower Don River area, Niagara Street near the Industrial Exhibition grounds, and Brockton Village near the city's north-west emerging industrial complex at the junction of three major railroad lines. These concentrations of the Catholic population confirm the pattern described by Goheen (1970, p.213). As distinctive as these particularly

high concentrations of Catholics were, there was a general pattern in which above average concentrations of Catholics existed in the southern-most neighbourhoods along the harbour front, as well as to the extreme western edge of the city. A clear demarcation line running parallel to the city's water front along present-day Dundas Street, divided the city into two zones; a southern Catholic one and a northern Protestant one. Despite the concentration of Catholics in these southern neighbourhoods, however, it is important to note that in all neighbourhoods the majority of the population was Protestant.

Not surprisingly, the three measures of class, housing conditions and culture are interrelated. A strong positive correlation ($r=0.67$) exists between the location quotients for assessed values and crowding. This is not surprising, given that we would expect those families who were living, by necessity, in the poorest housing, and thus among the city's lowest class, to also be among the most crowded. Both assessed value and crowding are each moderately correlated with religion as well ($r=0.55$ and $r=0.47$ respectively). Catholics were, on average, poorer and hence associated with material deprivation and with poor housing and environmental conditions. These relationships exist in a general way, but as the correlations are not perfect, some neighbourhoods scored high on one measure but low on others. Brockton Village, for example, scored very high in terms of a concentration of Catholic families (LQ = 2.8), but very low in terms of homes assessed below $300 (LQ =

0.5). Conversely, the two neighbourhood units comprising the Ward, had high proportions of homes assessed below the assessment threshold (LQ = 1.6 and 1.8), but they had very different location quotients in terms of Catholic population (0.6 and 1.4). Not surprisingly, some neighbourhoods scored high (or low) on all variables. Examples include Corktown and Niagara with high proportions of all three variables at one extreme, and the Annex, Parkdale and Rosedale at the other. For this reason, and because each variable was associated with mortality at the individual level, we would expect to observe a fairly marked social geography of childhood mortality.

4.6 - THE GEOGRAPHY OF CHILDHOOD DEATHS

To document the neighbourhood geography of mortality, the calculated observed-expected ratios (OER), discussed earlier, were mapped (**Figure 4.5**).[10] To some extent the pattern of infant mortality conformed to the stereotype of inner-city disease and suburban health. For infants, areas of low mortality exist in the city's east end (the Beaches), as well as on both sides of the Don River. Affluent suburban enclaves, to the north and west, such as the Annex and Parkdale respectively, also had low infant mortality. In contrast, with the

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10 The pattern of child mortality was, broadly, similar to that of infant mortality. In addition, many neighbourhoods had few child deaths. In all, 30 of 44 neighbourhoods had fewer than 5 child deaths. Due to the small number of child deaths, and the similarity of patterns with infants, the map of child deaths is not presented here.

exception of a few local pockets, much of the inner core of the city between the Don River in the east and Bathurst Street to the west, and south of Bloor St, were marked by above average to very high mortality. The contiguous neighbourhoods of Corktown, Cabbagetown-Regent Park and St Lawrence, in the south-east corner of the city's central core, were among the worst. Although infants in some inner-city neighbourhoods fared worse than those in some suburbs, this pattern was by no means consistent. To some extent this was predictable, given that patterns of class and cultural settlement did not conform to a neat Burgess model (Burgess, 1925). Towards the north-west of the city, for example, in working-class suburban neighbourhoods such as Brockton Village, the Junction, and Dovercourt, infant mortality levels were much higher than expected given the local fertility rates and population levels. In some neighbourhoods, however, mortality rates could not have been predicted either in theory or with reference to the city's social geography. Rosedale, for example, among one of the wealthiest and most prestigious neighbourhoods in all of Canada, though only in its early stages of development in 1901, had many more infant deaths than expected. A contrasting example, the Ward, in the very centre of the city, was long targeted by public health officials and politicians as a slum, and was among the neighbourhoods with the highest proportions of houses assessed below $300, but it had remarkably few infant deaths. Based on the local population, and controlling for local fertility levels, the two neighbourhood units of the Ward, combined, were expected to have 37 infant deaths. Only

38 infants died there, a remarkably small number given the rhetoric about the slum conditions, and supposed backwardness of the immigrants who often settled in this area upon arrival in the city.

4.7 - HOUSING, ECONOMY AND CULTURE

Visually, it is possible to discern some correlation between the pattern of childhood mortality and various descriptors of the social geography of the city. A more precise analysis of this relationship is possible through the use of regression analysis. Previous research, reported elsewhere, indicates that at the individual level crowding and religion were the major influences on childhood mortality in Toronto (Mercier, 2003b). The evidence reported here shows that neighbourhoods in Toronto differed more in terms of assessed value and religion than in terms of crowding. On the basis of these facts, we would expect that religion would be the single most important determinant of the geography of mortality. The regression analyses confirm this expectation.

Initially, simple regression models were developed to test the magnitude and direction of the association between measures of the socio-cultural composition of neighbourhoods, and the observed-expected mortality ratios. Of the socio-cultural variables,

religion had the strongest relationship with mortality (**Table 4.1**). Nearly thirty percent (29.5%) of the mortality variation is explained by the proportion of the neighbourhood belonging to the Catholic faith, and the relationship is in the positive direction, meaning that a greater proportional population of Catholics was associated with higher neighbourhood mortality. Eighty-five percent of the population was British-Protestant, and in some neighbourhoods, such as Rosedale and North Cabbagetown, the proportion was even higher. Others, however, like Corktown and Niagara had substantial Catholic-Irish minority populations. Since religion and ethnicity are so intertwined, it comes as little surprise that similar findings emerged through an analysis of ancestral origin. Nearly a quarter (23%) of the neighbourhood mortality variation is explained by the proportion of residents with British (non-Irish) ancestry, and the direction of the relationship is negative (**Table 4.1**). Given the social/cultural homogeneity of Toronto, and the fact that most of the families from the non-dominant groups, such as the Irish, Jewish and Italians, tended to settle in only one or two neighbourhoods, it is not surprising that the relationship between cultural affiliation and neighbourhood mortality is not higher.

Several measures of cultural affiliation, such as religion, or ethnic/ancestral origin, have been shown to be associated with mortality rates in other places (Mercier and Boone, 2002; Preston and Haines, 1991; Thornton and Olson, 2001). While the affiliation itself is

not so important, the true significance of the relationship lies with the cultural practices, such as household hygienic practices, breast or artificial feeding of infants, fertility practices and child care, that are generally tied to cultural background. For instance, differential breastfeeding practices have been linked to high rates of infant mortality among French-Canadians, Germans and Portugese, while strict adherence to sanitary laws by Jews have been linked to lower infant and child mortality rates among that population (Condran and Kramarow, 1991; Marks, 1994; Woodbury, 1925).

Simple bivariate regression models were also developed to test the association between neighbourhood mortality and the proportion of homes assessed below $300. Regression analysis indicated that less than two percent of the total OER variation between neighbourhoods is explained by the proportion of poor homes (**Table 4.1**). Despite the weak association, the direction of the relationship was as expected. Those neighbourhoods with lower proportions of households below the $300 threshold, had lower levels of mortality, though the relationship was not statistically significant. While mortality and social class were not strongly associated at the neighbourhood level, what about mortality and crowding? Again, a weak statistical relationship emerges between crowding and mortality, though the sign is in the expected direction (**Table 4.1**). The association between the proportion of households in the neighbourhood with greater than 0.7 persons per room, and neighbourhood

mortality is not significantly different from zero. Crowding, like social class, is not an effective predictor of neighbourhood levels of mortality. In light of Goheen's argument about the importance of social class as a determinant of the city's social geography by 1901, and given the contemporary slum rhetoric, this is a striking, if negative, result.

When assessed together in a multivariate stepwise regression, slightly over one third (36.9%) of the neighbourhood variation of childhood mortality is explained by a model consisting of two variables: the proportion of the neighbourhood population that is Catholic, and the proportion of the population with west European ancestry (**Table 4.1**).[11] At this level of analysis, variations in childhood mortality in 1901 Toronto are best explained by cultural affiliation, as described by religious affiliation (Catholic) and ethnic ancestry (West European). Though cultural factors outweigh economic and housing considerations, as neither assessed value or level of crowding is included in the regression model, much of the variation of mortality still remains unexplained.

In order to identify those neighbourhoods that had mortality rates significantly above, or below, what we would expect based on their social and physical characteristics, we can examine the residuals from the multiple regression model. In order to understand the

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11 Stepwise regression: $R^2 = 0.37$, p-value = 0.00; equation takes the form:
Childhood Deaths = 0.581 + 2.713 (Catholic) + 3.174 (West European).

geography of this relationship, the standardised residuals, which are the ordinary residuals divided by the standard deviation of the residuals, were mapped (**Figure 4.6**). Positive residuals occur when the model's predicted level of mortality underestimates the true level. Eight neighbourhoods had positive standardised residuals that were more than one standard deviation from the mean, and two of these were more than two standard deviations from the mean. The regression model was the least able to predict the level of mortality in Brockton Village (2.008) and Yonge-University (2.141). At the other extreme, seven neighbourhoods had negative standardised residuals that were more than one standard deviation from the mean.

While the spatial pattern of the residuals is difficult to interpret, a number of clusters do emerge. A concentration of negative residuals exist in the suburban, low-density neighbourhoods east of the Don River. Much of the central core surrounding the commercial district, including parts of the Ward and Corktown also have negative residuals. A third area of low residuals exists to the west of the city, near Parkdale, and including the neighbourhoods of Niagara, Trinity, Bellwoods, and Kensington. As for positive residuals, two main clusters emerge. The first, a fairly clear grouping in the north-western section of the city, includes several suburban working-class districts such as Brockton Village, the Junction and Dovercourt. The second cluster of positive residuals takes the shape of an

inverted horseshoe that extends northwards from the lake front and surrounds the central core. Included among this group are a series of neighbourhoods to the west of University Avenue including, the Garment District, McCaul, Queens Park-University, as well as a group of neighbourhoods to the east of Jarvis Street including much of Cabbagetown. Connecting these two groups, and incorporating the curved part of the horseshoe is Yorkville and Rosedale.

At the level of the individual family, its social class, housing and local environmental conditions, as well as its socio-cultural background were all found to be important determinants of mortality. However, at the neighbourhood-level, some of these associations disappear, and only socio-cultural affiliation explains a significant proportion of the mortality variation. How can we explain these findings? One possible explanation is that the impact of any of these factors varies according to the neighbourhood context. Students of voting behaviour, educational achievement, and population health are familiar with the concept of the 'neighbourhood effect'. Using educational achievement as an illustrative example, in general we see that after local resources and family characteristics are controlled, children in areas that are marked by social and environmental deprivation do worse than their counterparts elsewhere (Garner and Raudenbush, 1991; Wilms, 1986). It is plausible that similar types of contrasts existed in Toronto in 1901 with respect to

neighbourhood variations in childhood mortality. In particular, perhaps the health risks faced by the children of poor families varied from one type of neighbourhood to another. To some degree, this seems to have been the case. Neighbourhoods were divided into three groups based on their proportion of households below the $300 assessed property value threshold: i) less than 15% of households below the threshold, ii) between 15-30% of households below the threshold, and iii) greater than 30% of households assessed below $300. Observed-expected mortality ratios were then calculated, for each group, for only those families living in homes assessed below the threshold. In this way, the mortality risk of poor families in poor neighbourhoods could be compared to the risk of poor families in more affluent neighbourhoods. In general, we find some evidence of a neighbourhood effect, but not an overwhelmingly strong one. Poor families in poor neighbourhoods had 32% more deaths than expected (OER = 1.32), while poor families in middle neighbourhoods had slightly fewer deaths than expected (OER = 0.94). This is evidence of the neighbourhood effect. However, poor families in the most affluent neighbourhoods (those with fewer than 15% of households assessed below $300) had the greatest risk of childhood death of any of the three neighbourhood groupings (OER = 1.57). Moreover, the elevated mortality risk among poor families in affluent neighbourhoods can not be explained by other factors such as their levels of crowding or socio-cultural affiliation. While this finding does point to the existence, in a limited way, of a neighbourhood effect on childhood

mortality, it also helps to explain the weak association between assessed values and mortality.

Another explanation for the weak neighbourhood scale association between class or housing and mortality is the intra-neighbourhood variation of these measures. A couple of neighbourhood examples can clarify the point. Take, for example, two contiguous but highly different suburban neighbourhoods, the Annex and Dovercourt. The first, an upper- and middle-class neighbourhood home to many of the city's elite, the second, a working-class neighbourhood settled by many recent British immigrants. Levels of mortality were as different in these two neighbourhoods as were the social class of the resident populations. Mortality in Dovercourt was among the highest in the city, while few areas had lower levels of mortality than the Annex. In these neighbourhoods, class and mortality were closely connected. More importantly for the present argument, however, the assessed values of households in both neighbourhoods are tightly distributed around their respective means. The coefficient of variation, which allows for comparisons of relative dispersion, is low for both neighbourhoods.[12] By way of contrast, two central neighbourhoods, McCaul and Queen's Park-University, had high levels of mortality, but comparatively few households

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12 The coefficient of variation is calculated by dividing the mean by the standard deviation. The larger the coefficient, the greater is the deviation about the mean. The coefficient of variation for the entire city was 1.24 while for the Annex and Dovercourt the value was 0.58 and 0.64 respectively.

below the $300 threshold, and thus fit the general pattern of a weak relationship between class and mortality. Furthermore, the degree of variation of assessed values, as measured by the coefficient of variation, was high for both neighbourhoods (1.81 and 1.73 respectively). Therefore, while some variation in class existed between neighbourhoods, what may have mattered more was the variation within neighbourhoods.

One further neighbourhood example highlights the complexity of the issue at hand, namely that intra-neighbourhood variations, of all important determinants of mortality, can get lost when a neighbourhood perspective is used rather than an individual one. Take, for example, the Ward, "considered a slum from the beginning, its status confirmed by the city's placing of the local poor house" there in the mid-nineteenth century (Speisman, 1985, p.107). The Ward was among the city's most densely settled neighbourhoods, it had high levels of household crowding and poverty, and despite the provision of sanitary services to the area, most dwellings were not connected to them, especially the small cottages located in the numerous back alleys. In fact, outdoor privies and shared water wells continued to be used by many dwellings in the Ward well into the late 1910s (Hastings, 1911; Speisman,1985). We would expect, therefore, given these attributes, that the Ward should have had very high levels of mortality. Instead, mortality was only slightly above average in this area. The presence of a strong concentration of Jews in the Ward confounded the

issue. A quarter of the population of the Ward in 1901 was Jewish, a group that represented less than two percent of the entire city population. Even among these generally crowded and impoverished conditions, compared to their neighbours, the Jews were more crowded, equally disadvantaged economically, and at greater risk of having an infant or child die because of their extraordinarily high fertility rates. Despite this, however, the mortality of the Jews was, by far, the lowest of any group in the city, bar none. The extraordinarily low mortality of the Jews of the Ward helped to counter the high mortality of their Irish and Italian neighbours, and thus contributed to the Ward's average level of mortality. What this points to, I believe, are two things. First, intra-neighbourhood variation in terms of housing conditions, and socio-economic and socio-cultural characteristics, can significantly affect neighbourhood-level associations with mortality. Second, and most importantly, this example points to the importance of, above all else, cultural factors. Irrespective of the local housing and environmental context, Jewish families were able to manage those conditions and improve the chances of survival for their children. Italian and Irish neighbours, living in much the same environment, were not able to do the same.

4.8 - CONCLUSIONS

In Toronto in 1901 childhood mortality varied a good deal from one neighbourhood

to another, but not always in the expected or predictable ways. Mortality rates were high in fringe areas as well as the inner areas, and to a surprising degree such variations cannot be explained by social class or housing conditions. Instead, cultural affiliation, as expressed through religion (Catholic) and ancestry (Western European) seems to have been the strongest influence. Overall, the neighbourhood-level findings are disappointing, since only one third of the mortality variation could be explained by these important social distinctions. However, they have highlighted the importance of the city-wide variability of these determinants of mortality. A couple of neighbourhood examples have accented further the intra-neighbourhood variation of these factors. While these results, on the one hand, point to a need for more individual-level analyses to assess the determinants of childhood mortality, they also lend credence to the idea that further neighbourhood-level analyses are needed to help explain the remaining two thirds of the neighbourhood mortality variation. In particular, what is the nature of, and importance of, the neighbourhood effect in childhood mortality? What role did the provision of sanitary and other health services, such as sewers, clean drinking water, baby clinics, and milk distribution depots, play in the neighbourhood-level variation of childhood mortality? These are obviously important topics for future research. Such issues can sometimes be addressed by comparing mortality rates in areas that differ in terms of the presence of such services. Alternatively, and perhaps additionally, they could surely be illustrated by research that compares mortality rates in specified areas in the

years immediately before and after such services are provided. The present paper has attempted to indicate that such issues are important and could usefully be explored.

Figure 4.1 - Reference Map, Toronto, 1901 - Neighbourhoods, Major Streets, Railroads

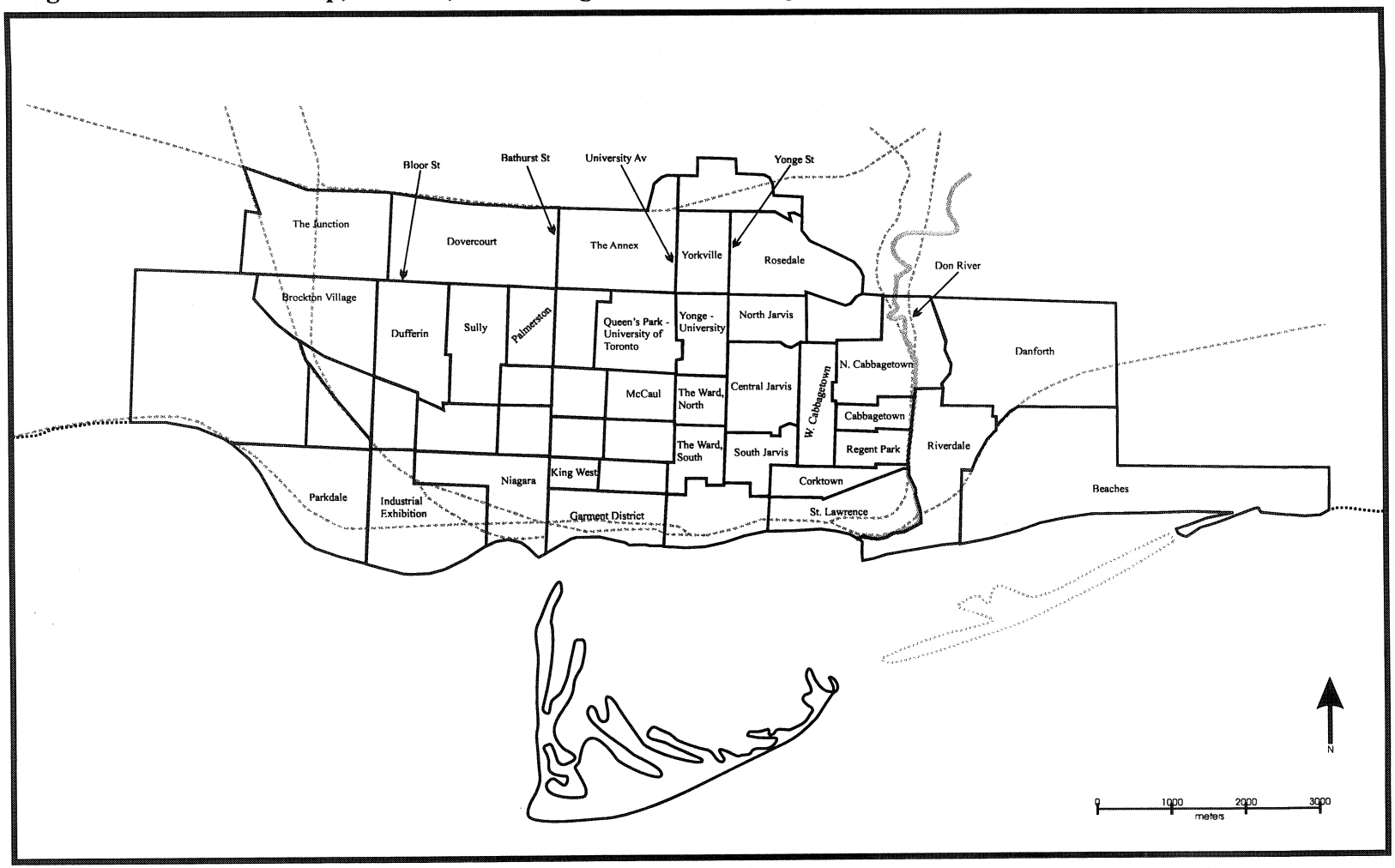

Figure 4.2 - Proportion of Households Assessed Below $300 (Location Quotients), Toronto, 1901

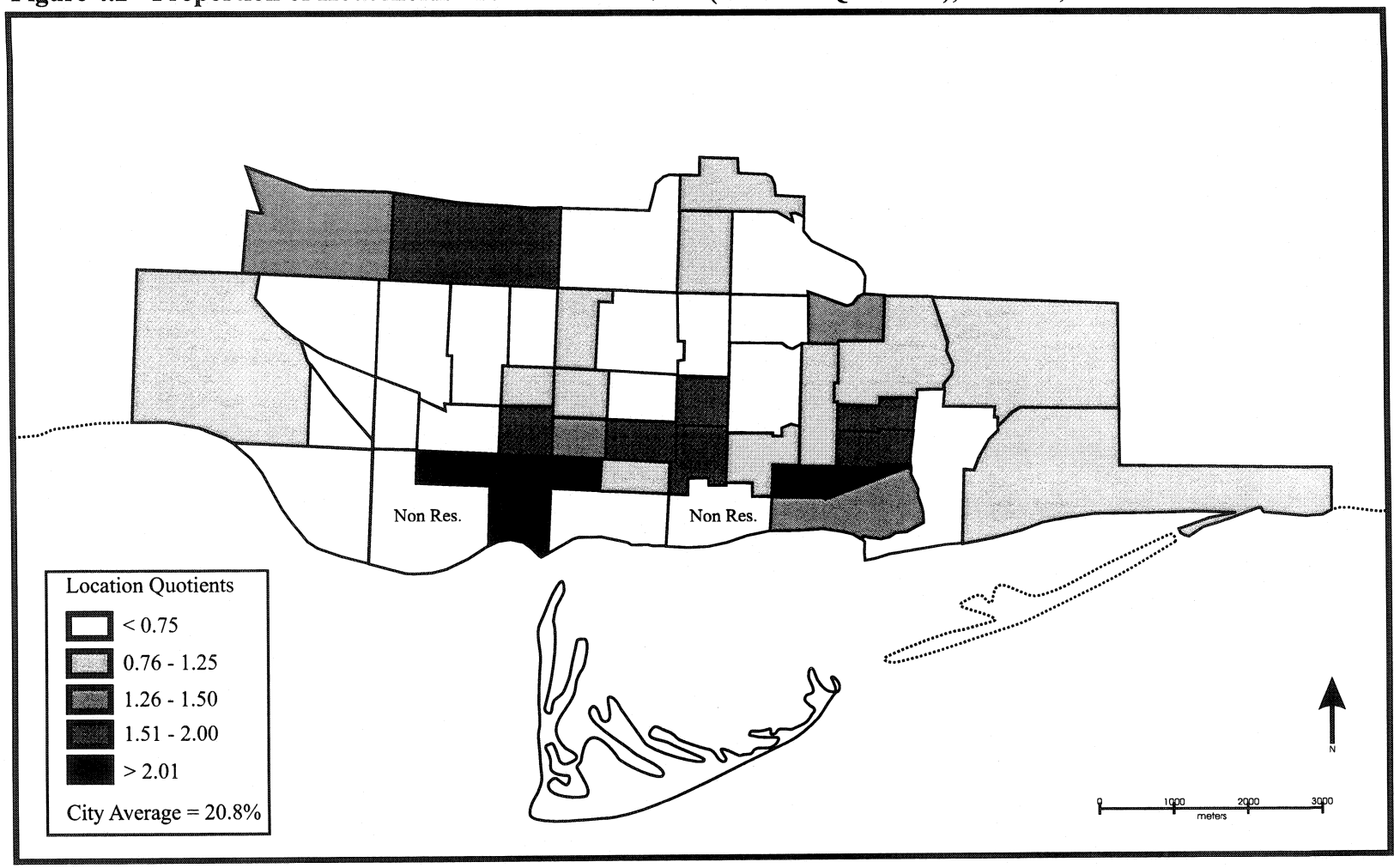

Figure 4.3 - Proportion of Crowded Households (Location Quotients), Toronto, 1901

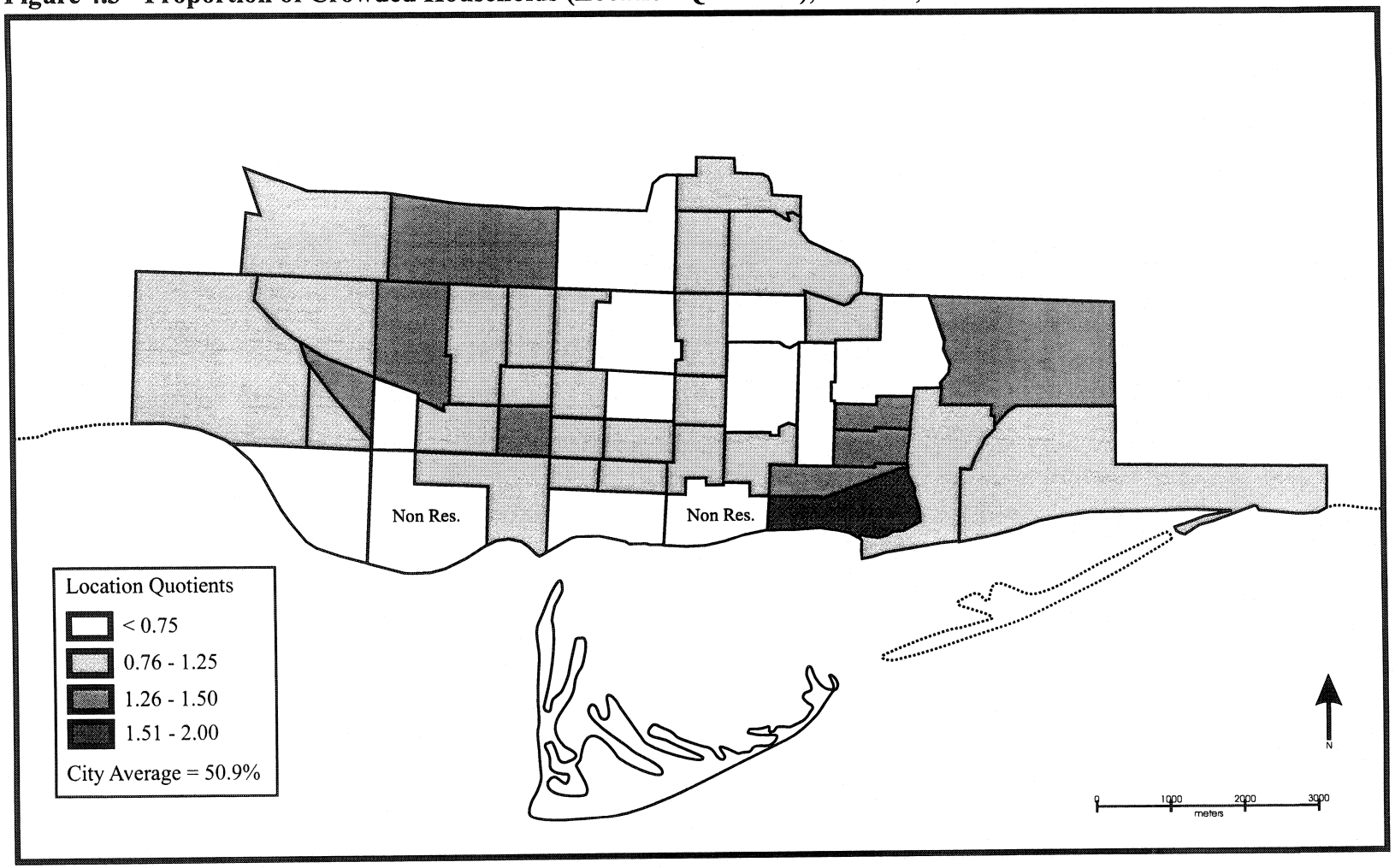

Figure 4.4 - Proportion of Households Affiliated with the Catholic Church (Location Quotients), Toronto, 1901

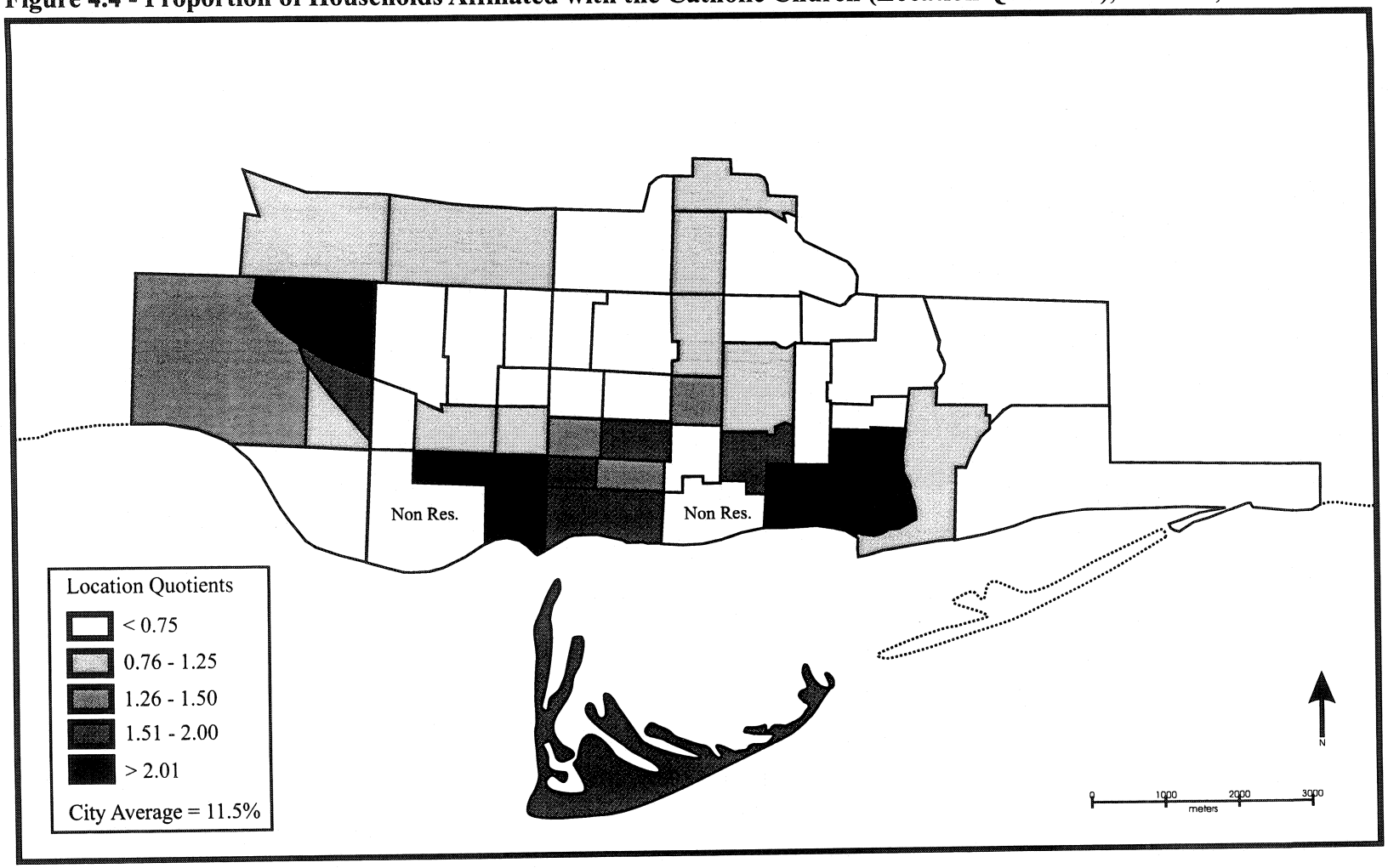

Figure 4.5 - Infant Mortality (Observed/Expected Ratios), Toronto, 1901

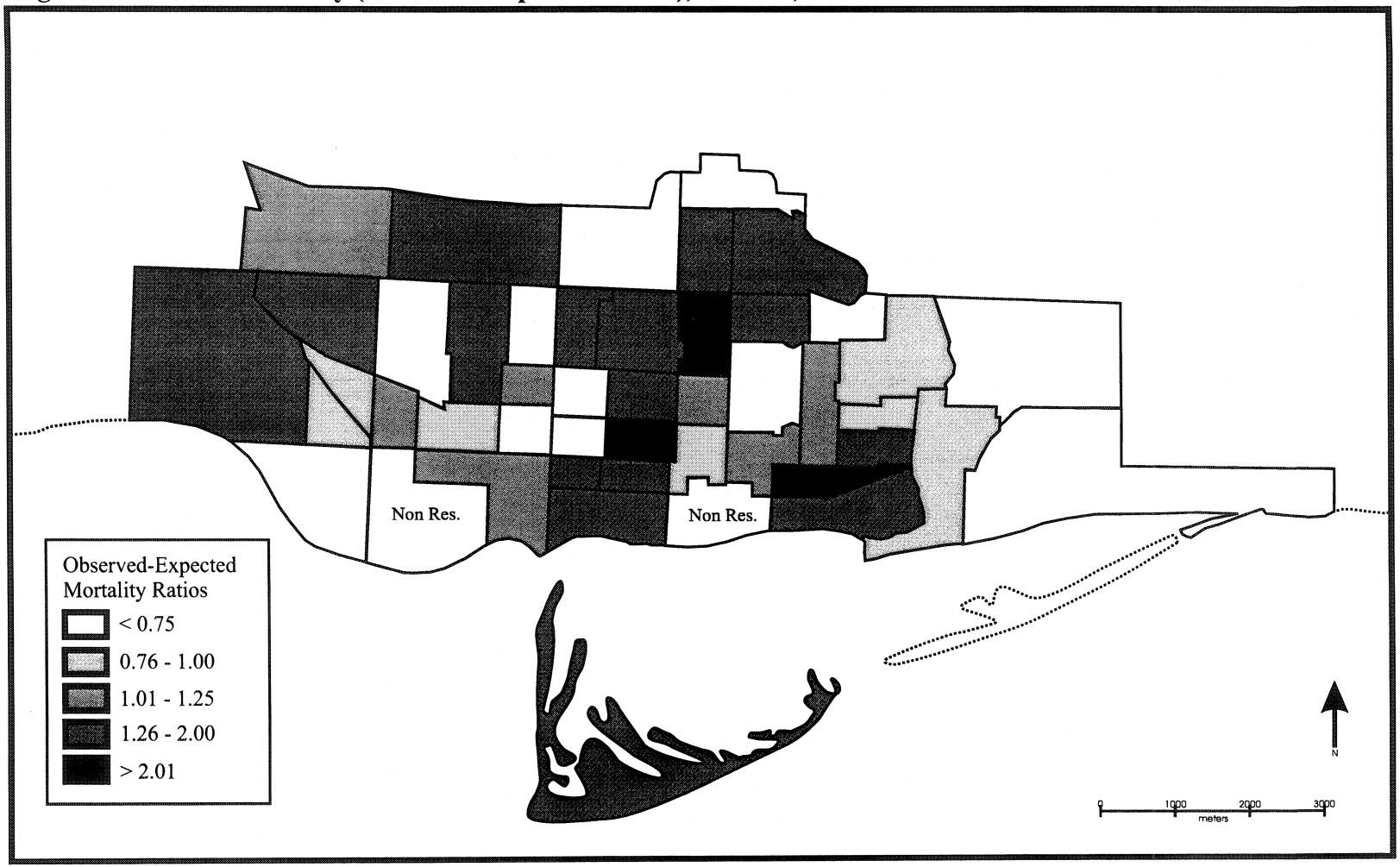

Figure 4.6 - Standardized Residuals, Childhood Mortality vs. Religion and Ancestry, Toronto, 1901

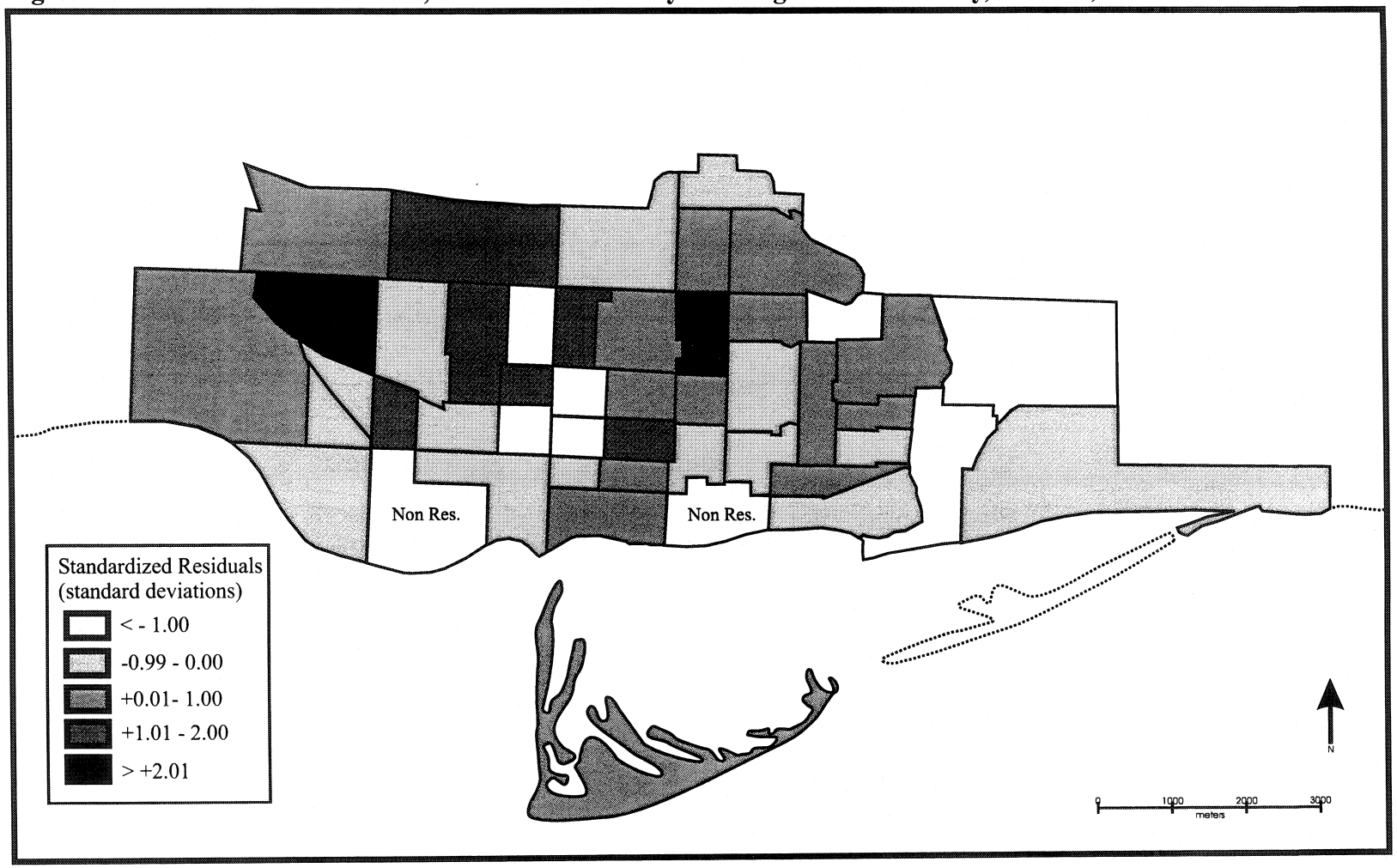

Table 4.1 - Regression Coefficients for Childhood Mortality vs. Select Neighbourhood Characteristics

Bivariate			**Bivariate**		
Religion	**R^2**	**Sig.**	**Ethnicity**	**R^2**	**Sig.**
Anglican (%)	(-) **0.09**	**0.043**	British (%) (excl. Irish-Catholics)	(-) **0.23**	**0.001**
Presbyterian (%)	(-) 0.01	0.618	Irish-Catholics (%)	(+) **0.22**	**0.001**
Methodist (%)	(-) 0.02	0.418	West European (%)	(+) **0.18**	**0.004**
Baptist (%)	(+) 0.03	0.259	East European (%)	(-) 0.00	0.992
Protestant (%) (Angl., Presb., Meth. & Bapt.)	(-) **0.14**	**0.012**			
Jewish (%)	(+) 0.00	0.783	**Nativity**	**R^2**	**Sig.**
Catholic (%)	(+) **0.30**	**0.000**	Ontario-born (%)	(-) 0.02	0.403
			North American-born (%) (excl. Ontario-born)	(+) **0.12**	**0.022**
Class (Assessed Value)	**R^2**	**Sig.**	Immigrant (%)	(-) 0.00	0.949
Median Assessed Value ($)	(-) 0.03	0.234			
Assessed Below $300 (%)	(+) 0.02	0.369	**Housing (Crowding)**	**R^2**	**Sig.**
			Median Level of Crowding (Persons per Room {PPR})	(+) 0.01	0.603
			Crowded (% > 0.70 PPR)	(+) 0.01	0.540

Multivariate			
	Coefficient	**Sig.**	**Multiple R^2 (Sig.)**
In Equation: Catholic (%)	(+) 2.713	**0.001**	**0.37 (0.000)**
In Equation: West European (%)	(+) 3.174	**0.034**	

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CHAPTER 5: CONCLUSIONS

5.1 - SUMMARY OF RESULTS

This thesis has examined the patterns and determinants of childhood mortality at three scales: city/region, neighbourhood, and individual household. For a region and time period largely neglected by demographic historians, it has documented both the provincial trend and the extent of the urban-rural differential for infant mortality rates in Ontario between 1881-1941 (Chapter 2). The results of the analysis confirm that infant mortality rates in Ontario declined shortly after the turn of the twentieth century, at approximately the same time as in the United States and Europe. The urban-rural mortality differential was also as significant and persistent in Ontario as elsewhere. The thesis also explored the relationships between urban infant mortality rates in Ontario and specific ecological-level indicators of the nature of the urban experience, notably city size, population density, household crowding, and the socio-cultural composition of the population (Chapter 2). In particular, these measures of urban difference were used to explain the inter-urban variation in urban infant mortality rates in Ontario in the period of mortality decline. City size, population density, and household crowding did not satisfactorily explain the urban variation in mortality rates. Instead, the socio-cultural composition of the population, and in particular the proportion of the urban population that is French-Canadian, explained the greatest share of the pattern.

At the scale of the individual household, utilising archival data sources, the thesis explored the determinants of infant and child mortality for Toronto in 1901 (Chapter 3). In particular, the analytical focus was on assessing, through bivariate analyses, the independent importance to the incidence of childhood deaths of occupation, housing type and size, crowding, family size, socio-economic class, ethnicity, nativity, and religion. Measures of social class produced mixed results. Neither occupational class nor maternal employment outside the home were statistically significant determinants of infant and child mortality. Assessed property values, on the other hand, were a significant predictor of mortality. While it was expected that the relationship between assessed values and mortality would be linear, in fact the relationship was dichotomous. Those households living in accommodation that was assessed below $300 had elevated levels of mortality, while those above this threshold experienced much lower levels of mortality. In a similar way, housing conditions, as measured by internal household crowding, was also an important determinant of mortality. Again, a dichotomous relationship emerged. Those households with greater than 0.7 persons per room had elevated mortality, while those below this crowding threshold had lower mortality. The dichotomous nature of the relationships between mortality and both crowding and class was unexpected, indicating the presence of significant causal thresholds. The direction of the relationships were as predicted; poorer housing conditions and lower social class, as measured by levels of crowding and material circumstances respectively,

were associated with higher levels of mortality.

At the household scale, several socio-cultural factors were also found to be associated with mortality risk in Toronto in 1901 (Chapter 3). In particular, ethnic/ancestral origin, religious affiliation and nativity were all associated with differential levels of mortality. The most important of these, however, was the relationship between mortality and religion. While some variation in mortality risk existed between the four major Protestant religions (Anglican, Methodist, Presbyterian and Baptist) which accounted for about 80% of the population, taken as a whole mortality levels for this group were on par with what we would expect given their levels of fertility and proportion of the total population. Most importantly, however, was the widely divergent mortality experiences of Catholics and Jews. Jews, though small in number, had 75% fewer deaths than expected based on their proportion of the general population and fertility rates, while Catholics on the other hand, had a statistically significant elevated mortality risk. These socio-cultural differences in mortality rates existed even after other factors such as social class and levels of household crowding were accounted for. The divergent mortality experiences of socio-cultural groups, therefore, point to the possibility that these mortality differentials may be explained by differing cultural practices such as breastfeeding, hygiene, food preparation, and fertility.

Having established the independent importance of measures of class, culture and housing, the focus of the thesis turned to establishing which factors had the greatest influence on the incidence of childhood mortality (Chapter 3). While housing conditions (crowding) and social class (assessed values) were closely related, bivariate analysis determined that of the two, crowding was the more important determinant of childhood mortality. In other words, the effect of assessed values on mortality was explained almost entirely by variations in crowding. When isolating socio-cultural differences from those of social class or crowding the conclusions became much less clear. The contrasting experiences of Catholics and Jews provide the most salient example of this. In general, Catholic and Jewish families lived in the most crowded homes, and their social status were among the lowest in the city. Despite these parallel experiences in terms of class and housing, the mortality rates of these two groups could not be more different. While in some ways it is most tempting to conclude that socio-cultural affiliation, as best defined by religion, was the single most important determinant of childhood mortality in Toronto, multivariate analysis suggests that the ultimate answer lies within a complex interplay of socio-cultural, and housing factors. Though the strength of the logistic regression model was below the desired level, the analysis did confirm the importance of fertility, crowding, socio-cultural affiliation (religion and nativity), and household structure as significant determinants of childhood mortality in Toronto in 1901. In the end, social class, had little

impact on the incidence of childhood mortality, but that levels of household crowding and structure, and socio-cultural affiliation did.

Having established the importance, through bivariate analysis, of class, culture and housing conditions to the incidence of mortality at the individual scale, the final objective of the thesis was to take a social geographic perspective and assess the importance of these measures in explaining the neighbourhood variations of childhood mortality (Chapter 4). Childhood mortality varied a good deal from one neighbourhood to another, but not always in the expected or predictable ways. Mortality rates were equally high in suburban fringe areas and inner-city slums, and to a surprising degree such variations could not be explained by social class or housing conditions. Instead, cultural affiliation, as expressed through religion and ancestry, seems to have had the strongest influence. While only about a third of the neighbourhood mortality variation is explained by these important determinants of mortality, the importance of cultural background in this regard further emphasizes those findings made at the scale of the individual and the urban system as a whole. In the context of turn of the twentieth century Toronto, regardless of the scale of analysis, cultural factors appear to be the most important determinant of childhood mortality.

5.2 - THEORETICAL CONTRIBUTIONS

The analysis of inter-urban mortality variations in Ontario contributes to our theoretical understanding of the relationship between the nature of urban places and levels of mortality. Urban, environmental, and demographic historians commonly make assumptions about the influence of city size and population density to the level of mortality. The findings of Chapter 2 suggest, however, that these assumptions, at least in the case of Ontario cities, are poorly grounded in fact. A greater influence on the level of mortality comes from the socio-cultural composition of the urban population. A further contribution of the thesis is that, for the first time, we have a clear understanding of the timing, and spatial variation, of infant mortality decline in a North American setting.

The local case study of Toronto in 1901, developed from individual-level death record data, makes a number of important contributions to historical demographic theory. First, it confirms the independent significance of both socio-economic and housing determinants of infant and child mortality. Of the two, housing conditions, as measured by the level of internal household crowding is the more important. In addition, this thesis has shown that socio-cultural factors such as religious affiliation, nativity and ancestral origin were also important determinants of mortality. The results point us to conclusions about the

importance of cultural practices, associated with particular cultural groups, to the incidence of childhood mortality. In some cases, such as fertility and family size, we have measurable evidence of the variation of these cultural practices among socio-cultural groups. Some ethnic and religious groups, such as Jews and Catholics in particular, were more likely to have large families which were found to be associated with higher levels of childhood mortality. In other ways, however, we are not able to measure cultural practices. For instance, the nature and type of hygienic practices within the home, the method of food preparation, or even rates of breastfeeding all remain largely unknown. In the case of eastern European Jews, however, this thesis has provided evidence that suggests that in some way their cultural practices allowed them to overcome harsh socio-economic and environmental hardships, the same hardships that the Catholic population, perhaps because of their own cultural practices, were unable to overcome. While each of social class, housing conditions, and socio-cultural affiliation were important determinants of infant and child mortality, socio-cultural factors, such as specific feeding, hygiene and child-rearing practices were seemingly more important.

Two major theoretical contributions arise from the analysis of childhood mortality at the neighbourhood level. First, the social geography of Toronto in 1901 was more heavily marked by socio-cultural differences (ie. ethnicity and religion) than previous analyses have

revealed. Eastern European Jews were highly segregated in 1901, and Toronto's Catholic community was also strongly segregated. Second, mortality varied from one neighbourhood to another, but not always in the expected ways. Neighbourhoods with high levels of childhood mortality were found in all areas of the city, including inner-city and suburban areas alike. This runs counter to our general conceptualizations of the health of turn of the century cities, in which inner-city slums of disease are juxtaposed with suburban healthfulness. Furthermore, the determinants of mortality as explored in Chapter 3, explain only one third of the neighbourhood variation in mortality levels, leaving fully two thirds to be explained.

5.3 - METHODOLOGICAL CONTRIBUTIONS

Three significant methodological contributions emerge from this thesis. First, the use of an under-utilized data source, the individual-level death records for the city of Toronto, in conjunction with other individual-level data sources such as the manuscript Census of Canada, local tax assessment rolls, and city directories, allow for greater analytical precision than can be achieved through aggregate-level published statistics. This individual-level database, constructed through the methods of record-linkage, while extremely time consuming to collect offers unique analytical opportunities, many of which

have been undertaken in this thesis. A second methodological contribution involves the use, for the first time, of a stratified sample of the 1901 manuscript Census of Canada to examine the social geography of Toronto. In this thesis, the social geography of Toronto has been examined in the context of how it relates to mortality, but other analytical opportunities exist to use this valuable data source for other research endeavours.

The third methodological contribution of this thesis comes from the construction of a framework for the analysis of neighbourhood social and mortality patterns. While several different areal units were available for the analysis of the social geography of childhood mortality, none were of the right size or number. Political wards, tax assessment divisions, and Census districts and sub-districts were all too large to allow for meaningful interpretation, and Census polling sub-divisions were similarly too small. The solution involved joining the small sub-divisions into a manageable number (44) of logically defined neighbourhoods. While the number of, and boundaries of, the neighbourhoods chosen here may be open for debate, the use of this technique is applicable to any analysis of social geographic patterns in Canadian cities using the 1901 manuscript Census.

5.4 - DIRECTIONS FOR FUTURE RESEARCH

While it is apparent that a community's cultural composition had an important effect on its overall infant mortality rate, and that other urban characteristics of the place such as population size, density and crowding were less significant, a sizeable proportion of the mortality variation between the province's urban places remains to be explained. One potentially fruitful avenue for inquiry is the level of investment in, and differing chronology of, public health, and especially sanitation, by individual cities. Those cities that we may have expected to have had high mortality rates, such as Toronto and Hamilton, may have effectively negated the impact of their size, density and crowding through such investments, while others such as Ottawa may have exacerbated their problems through the delayed implementation of public health. Local level urban studies, that can assess the contributions of public health initiatives to mortality decline will help address this important issue.

Results of the household level analyses highlighted other important issues requiring further research. For instance, can the different cultural practices of Jews and Catholics in Toronto, to name the most obvious examples, be ascertained and evaluated as to their direct influence on the incidence of infant and child mortality? Furthermore, what impact, other than what has been measured here, did differential fertility have on childhood mortality?

Finally, the multivariate analysis suggests that critical explanatory variables have not yet been accounted for. It is likely that the provision of public health and sanitary services was important to the incidence of childhood mortality, and so documenting the availability of sanitary services across the city, may contribute to a new understanding of the way that public health influenced individual health risks.

The results of the neighbourhood-level analysis suggest that further neighbourhood-level analyses are needed to help explain the remaining two thirds of the neighbourhood mortality variation. In particular, what is the nature of, and importance of, the neighbourhood effect in childhood mortality? What role did the provision of sanitary and other health services, such as sewers, clean drinking water, baby clinics, and milk distribution depots, play in the neighbourhood-level variation of childhood mortality? These are obviously important topics for future research. Such issues can sometimes be addressed by comparing mortality rates in areas that differ in terms of the presence of such services. Alternatively, and perhaps additionally, they could surely be illustrated by research that compares mortality rates in specified areas in the years immediately before and after such services are provided. This thesis has indicated that such issues are important and could usefully be explored.