Community Health Indicators for Ontario Public Health Units:

An Evaluation of the Ontario Community Health Profile

by

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Shalom.

Abstract

The Ontario Community Health Profile was developed in the early 1990s in response to a need for better measurement of community health in the province. This thesis conceptually and empirically evaluates the profile's relevance, representativeness and practicality for measuring community health in Ontario public health units.

Based on a review of the literature and various models of community health, community health is defined as more than simply the absence of disease or disability among a collection of individuals. Health must encompass both disabling and enabling characteristics — defined here as measures of negative or positive health — that are related to coping ability. Moreover, *community* health indicators should encompass levels of measurement that are global and environmental (representing health 'of' the community) as well as aggregate measures (representing health 'in' the community). This paper develops a community health framework — with axes representing the definition of health and the level of community — in order to evaluate indicators according to these two important dimensions. Empirical analyses used data from the HEaLth Planning System (HELPS) data set for Eastern Ontario.

The health status indicators in the Ontario Community Health Profile appear to be oriented toward a biomedical approach to community health — negative measures of health 'in' the community. The calculation of standardized incidence ratios and a chi-square analysis indicate a significant amount of diversity among communities within health units. Given this diversity, indicator values reported as aggregate measures at the health unit level may not be very representative of those communities. Analysis using coefficient of variation suggests that health status indicators generally provide stable single-year estimates at the health unit level,

but five-year estimates may be required for some of the less common phenomena, including cause-specific and age-specific mortality rates such as infant mortality rate and suicide mortality rate. Calculation of the indicators is complicated by the use of three separate coding schemes — health unit codes, geocodes, and census codes — as well as some serious problems with coding errors at the CSD-level. The profile is further limited by a heavy reliance on the Ontario Health Survey. As such, the level of disaggregation at which many indicators are available, as well as their timeliness, is quite limited.

Redundancies among the health status indicators, which were identified through bivariate correlations and confirmed with tests of collinearity, may be reduced by using a subset of 15 indicators. Proxy indicators that represent a range of health status indicators may also be used to increase the parsimony of the profile. Correlation analysis identified health-adjusted life expectancy and standardized premature mortality ratio as two potential proxies that together appear to be correlated with a number of the health status indicators. Tested against these two proxies, the parsimonious set appears to significantly reduce redundancies, but may also result in a moderate loss of explanatory power. Based on those conclusions, the thesis makes recommendations for improving the relevance, representativeness and practicality of the OCHP.

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Introduction

Measurement and surveillance are essential tools in community health planning and intervention. Without a way of assessing or detecting changes in community health, health policy and health initiatives are rather arbitrary undertakings. Improving the quality of our measurements is a step toward more responsive and responsible action for community health. This thesis examines one approach to the measurement of community health in Ontario -- the Ontario Community Health Profile.

Earlier this decade, the Ontario Ministry of Health established a 'Community Health Framework Project' to review the state of the province's public health system and make recommendations for its reform.[1] The reports of the Framework Project recognized the need for easier access to data through 'Health Intelligence Units' (later renamed 'Health Information Partnerships') that would act as data clearinghouses and support Ontario's 42 health units to monitor and evaluate health in their regions. These organizations have since been formed, increasing the capacity of local health units to make use of available health data. To facilitate province-wide community health monitoring and assessment, the Framework Project also recommended the use of a Community Health Profile.

The Ontario Community Health Profile (OCHP) contains 66 indicators in 6 categories, based on an earlier profile intended for national use: the Canadian Health Information System (see Appendix 1). The purpose of the profile is to help bring together information from a range of sources on the health of communities in Ontario. It is meant to act as a template, providing 'a consistent list of indicators that would be used across the province'.[2] It emphasizes comparability across regions and time periods, as well as making information accessible to the community. The template is now available in software form for PHUs to use in putting together community health reports.[3]

While the profile has been adopted to varying degrees by health units across the province, there have been no formal conceptual or empirical evaluations of its utility or validity. In fact, although similar profiles have been developed for community health assessment in many settings, the literature contains little on frameworks or criteria to evaluate such profiles. Thus, before proceeding to the evaluation of the OCHP, It will be necessary first to develop a framework by which the profile may be conceptually evaluated, and, based on a review of the literature, describe a set of criteria for the selection and testing of community health indicators in general. Having evaluated the OCHP according to these criteria, this paper suggests modifications to the current profile, including alternative or additional indicators.

This report uses the terms 'indicator', 'profile' and 'index' as they are commonly understood in the literature. An **indicator** is a single measure whose value corresponds to a particular event or outcome. A **profile** is a set of community health indicators which, taken together are meant to represent a range of relevant health concepts and issues. Profiles may present indicators in specific categories, but make no attempt to provide summary scores for those categories, or for health overall. An **index** is a single summary score which reflects the values of a group of indicators and represents a broader concept or underlying phenomenon.

Objectives

The thesis has four main objectives:

1. *Develop a framework, rooted in a definition of community health, to conceptually evaluate community health profiles.*

2. *Describe a set of criteria by which community health indicators can be selected and tested.*

3. *Conceptually and empirically evaluate OCHP indicators according to the criteria.*

4. *Based on the results of the evaluation, suggest alternative or additional indicators.*

Chapter 1

Community Health Definitions and Dynamics

A framework for evaluating the comprehensiveness of community health profiles

This chapter begins by examining definitions of community health. In a paper on community participation in health programmes, G.B. Woelk writes, "Two major conceptual and practical difficulties underlie attempts to define and interpret community participation.... These difficulties concern 'community' and 'participation.'"[4] Our difficulties concern 'community' and 'health'. Thus, I will proceed by looking first at alternative definitions of 'health' and second at definitions of 'community' in the context of health. These definitions form the basis of a two-dimensional framework for evaluating how well a set of indicators covers the concept of community health. The final section discusses the dynamics of health in terms of historical paradigms of health measurement, illustrating how different approaches to community health have focused on different aspects of the community health framework.

Defining Health: Beyond Disease

> "Health is a state of complete physical, mental and social well-being, and not merely the absence of disease and infirmity."
> – WHO 1948

> "The WHO definition is thus difficult to use as the basis for health policy, because implicitly it includes *all* policy as health policy."
> – Evans and Stoddart 1990

Health and Well-being

There has been a steady trend during this century to broaden definitions of health from the absence of disease to include positive elements and quality of life. An expanding definition of health runs the risk of becoming so inclusive that it ceases to be a meaningful term. Indeed, as Frankish *et al.* point out, one even encounters tautologies such as the American Journal of Health Promotion's definition "optimal *health*... [is] a balance of physical, emotional, social, spiritual and intellectual *health*"[5] (italics mine). The WHO definition quoted above has received widespread acceptance on a political level. In a 1992 review of Canadian provincial health programs Mhatre and Deber found that all implicitly or explicitly adopted the WHO 1948 definition of health.[6] However, the definition is so all-encompassing it is hard to imagine any area of policy that would not be included in a discussion of 'health'. Some public health researchers welcome this holistic approach, recognizing the importance of all sectors to healthy populations.[7] Nevertheless, it raises some dilemmas for those in what is currently known as the 'health sector'. The specific roles of researchers, practitioners and policy makers in health care and public health settings must be taken into account when proposing such a broad definition. Otherwise, we risk holding our district health councils and public health departments responsible for the entire range of societal ills. Instead, a narrower definition of 'health' in a broader context of 'well-being' has more pragmatic value to measurement and practice in the field of public health.

Conceptual frameworks proposed by Hay *et al.*[8] and Evans and Stoddart[9] distinguish health from well-being. Evans and Stoddart define well-being broadly as "sense of life satisfaction," which is influenced by, and in turn influences, health and function. They suggest that well-being should be the ultimate goal of health policy, but that the immediate effect of health policy is on health. The view of health as a necessary but not sufficient condition for well-being helps to narrow the discourse somewhat, and is in accordance with the WHO's assertion in the Ottawa Charter for Health Promotion that health is a 'resource for everyday life, not the objective of living'.[10]

A more specific definition of health is required to define a more restricted role for public health workers within the broader context of well-being. I propose that this definition of health encompass two main perspectives: the biomedical or 'negative definition of health' approach, and positive health.

A Negative Definition of Health: The Biomedical Approach

Traditional, biomedical approaches to health measurement generally define perfect health as the absence of disease. Many community health assessment models are based on a biomedical definition of health. One recent example is the Manitoba Population Health Information System which states "Health status reflects the absence or presence of disease and functional impairments".[11] This is a negative definition of health as it defines health by what it is not, rather than what it is. Evans and Stoddart, forming the basis of the Canadian Institute for Advanced Research's community health model, offer a similar definition of health "...from the patient's perspective, as the absence of illness or injury, of distressing symptoms or impaired capacity."[9] There are several advantages to a negative definition. Disease and death are events that are fairly easily identified and quantified. Most of the contact between the medical establishment and the general population is with sick people, again shifting the focus of research and measurement to the incidence of disease, disability, and death. Most importantly, the measurement of disease is not merely a matter of convenience; morbidity and mortality are very real sources of suffering within a population which we do well to avoid or reduce. Nevertheless, there are good reasons to define health as more than simply 'the absence of disease or infirmity.'

One major limitation of morbidity and mortality rates is that they measure only the extreme of ill health (generally being sick enough to warrant a physician or hospital visit). As such, they tend to be late, rather than early indicators of adverse health conditions, reducing their sensitivity to changes in health status. Also, they do not distinguish between levels of health which do not necessarily result in disease or death (for example, levels of functional ability or self-perceived health).[12]

Underlining the need to expand our definition of health, a study by Mackenbach *et al.* suggests that the determinants of good health (a combination of self-assessed health status and absence of key health problems), while similar, may be distinct from those of ill health.[13] Thus, we should not assume that, by focusing on the factors which reduce disease, we are *de facto* promoting good health to its fullest. The general experience of 'health' in a population may have much less to do with disease than is reflected in current frameworks for community health measurement.

Positive Health

Despite its ambiguity, the WHO 1948 definition of health was an important step, going beyond the simple avoidance or treatment of disease toward a concept of 'positive health.' Since then, many researchers have attempted to understand what it means for individuals and societies to become 'more healthy', not simply 'less sick.' It is not yet clear exactly how to conceptualize positive health. Episodes of disease and disability are generally noticeable, relatively measurable aberrations. Good health, on the other hand, is seen more as a state of being than an 'episode,' making it more difficult to isolate and measure. One major challenge to the measurement of positive health is the difficulty of defining an ideal state. In a disease model, the ideal state can be defined as the complete absence of disease (morbidity rates = 0). However, we do not have an ideal of positive health, making it difficult to score or scale healthiness as a percentage of an ideal state.

So, is it possible to define positive health in more definite terms? Some contend that we lack the language to describe or express concepts of positive health.[12] Other, more optimistic thinkers have attempted to define positive health as a concept distinct from disease which involves resiliency and coping skills and is related more to future than current function.[14,15] Frankish *et al.* define health as "the capacity of people to adapt to, respond to, or control life's challenges and changes."[5] Among these approaches we see common themes of balance, capacity and coping. Noack divides these into two main concepts: health balance and health potential.[16,17] He defines health balance as dynamic equilibrium, functioning as a whole person or system. This includes the absence of symptoms, disease or disability, but also takes into account functional outcomes and well-being (Noack does not distinguish this from health). At the individual level, he describes this as 'internal dynamic equilibrium.' At the community level, this may translate into stability of health outcomes over time. Noack suggests that health balance is the main thrust of medical treatment and care.

Conversely, health potential is the focus of health promotion. This consists of "health related action" including health monitoring and activities which build capacity for coping. In other words, positive health at present should manifest itself in an increased probability of remaining healthy over time. Kaplan refers to this as the 'prognosis component' of positive health measurement.[15] This view of health more as process than outcome is reflected in the Agroecosystem Health Project's definition of health: "Health is considered a socially defined, complex, biological resource for daily living, which allows the entity to retain the capacity for self-renewal and withstand stress in the future."[7] At the individual level, this includes nutrition, immune system factors, knowledge, lifestyle and coping mechanisms. At the community level, the focus is on action to maintain health balance through policy, budgets, employment, social security, housing, safety, and access to services.

In short, health potential represents *capacity* for coping and adapting to future challenges, whereas health balance reflects the current or recent *state* or *level* of coping in a given population. These are not easy concepts to measure. Positive health understood in these terms is not something one can directly measure — one of the reasons that there is very little actual measurement of positive health in current community health monitoring. Rather, we must rely on indicators related to factors that affect coping ability and outcomes of that process. It is clear that negative health outcomes have a significant effect on health balance and potential. Put simply, illness and disability reduce the capacity to cope with future stresses, and indicate a poor level of coping with current stress. Thus, negative and positive definitions of health represent disabling and enabling factors in a continuum of coping ability, rather than a dichotomy of diametrically opposed approaches.

In conclusion, health involves *processes along a continuum from the absence of disease to balance and capacity for coping with future stresses*. Given this definition, positive and negative perspectives are not in opposition, but rather act in concert to both 'push' and 'pull' individuals and communities toward better health. Becoming less sick (the focus of preventive interventions) is a push in the direction of health through the elimination or reduction of disabling factors, measured by negative health indicators. Becoming more healthy (the focus of health promotion) is a pull in the direction of health through the addition or enhancement of enabling factors as measured by positive health indicators. Both should be present for optimal health. Certain measures contain elements of both positive and negative perspectives. Thus, they can be classified along a continuum between the two. Figure 1.1 presents some examples of health indicators placed along this continuum.

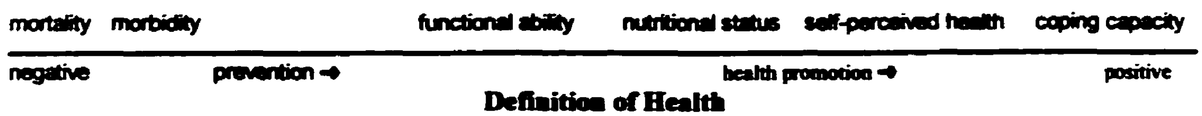


Figure 1.1 *Examples of indicators placed along the continuum between negative and positive definitions of health*

Most of these theories focus on the health of the individual, rather than that of the population or community as a whole. Having described approaches to the health concept, I now move to understandings of 'community' in the context of health.

Defining Community: Health 'in' and Health 'of' the Community

The Ottawa-Carleton Health Department's 'Framework for Health Department Programs' outlines two general pathways for health promotion. One focuses on the individual, highlighting self care capacity and action, resulting in optimal health for the individual or family. The second describes collective capacity and action, resulting in optimal community health. While the model acknowledges considerable interaction between these two pathways, it draws an important distinction, often unclear in community health measurement, between the health of groups of individuals and population health. Similarly, one of the Ontario Community Health Profile goals is to 'describe the health of the individuals in a community as well as the community itself.'[3] The former could be termed health 'in' the community, whereas the latter may be viewed as health 'of' the community. Both views represent valid and inter-related concerns. Nonetheless, they represent distinct approaches to measuring community health as discussed in the following paragraphs.

Individual

Clinicians treat individual people and are concerned with measures of risk or prognosis for individuals. Thus, measures of risk to the individual such as relative risk and odds ratios are the focus of much epidemiological research. By comparing individuals with and without a particular exposure (cohort studies) or disease (case-control studies) we attempt to explain why certain individuals within a population get sick while others do not. From an individual perspective, population-level measures such as morbidity or mortality rates are viewed as indicators of risk for individuals within that population. Thus, the importance of a community breast cancer mortality rate which is twice the average lies in the fact that individuals within that community are expected to run twice the risk of dying from breast cancer as individuals from the wider population. Research explaining what makes certain individuals more susceptible to breast cancer is then applied to try and explain the higher risk for people in this particular community. Again, the focus remains on the implications of community-level measures for individual risk.

Population

> "Prevention at the societal level, conceptualized as intervening with individuals en masse is often nullified when the target is a social entity with its own laws and dynamics."
> – Susser 1996a

Public health planners and policy makers deal mainly with population-level interventions and are thus interested in measuring incidence at the population level. While the reduction of individual-level risk and reduction of population-level incidence may at first appear to be one and the same, there are some important differences between the two. From a population perspective, the importance of morbidity and mortality rates is what they indicate about the overall burden of disease or death in a community. Rose points out that, in many situations, the majority of cases arise from those who are at medium risk simply because, assuming a fairly normal distribution for any given risk factor in the population, that is where we find the majority of people.[18] Thus, as he demonstrates, a small risk spread through a large population can generate many more cases than a large risk concentrated in a relatively small group of people. The resulting argument is that a small reduction in risk across a population may reduce the number of cases far more effectively than any attempt to achieve larger risk reductions in the high-risk segment of the population. This is graphically illustrated with the shifting of the normal curve down a gradient of risk, rather than truncating the distribution by focusing interventions on the high-risk tail of the distribution. In many cases, then, the overall shape of the distribution remains unchanged as all members of the population have a similar reduction in risk. If this is indeed the case, the number of people in a high risk category will be reduced as the curve is shifted. This has received some empirical support in studies of, among others, heart disease and salt intake,[18] and the effect on mortality of mild/moderate malnutrition versus severe malnutrition.[19]

Rose also proposes a 'sociological argument' for population-level prevention which emphasizes the fact that those at the tail end of a distribution remain an integral part of that distribution, not separate from it as certain high-risk approaches may imply. It can be argued also that the population approach, in dealing with the factors affecting incidence in the entire population, will ultimately have a more sustainable effect on the health of both individuals and the overall community than the targeting of high-risk individuals. The health promotion literature also suggests that population-wide campaigns tend to make change the norm, rather than the responsibility (often resisted) of a select group of people labeled 'high-risk.'[20]

This approach to community health intervention, focusing on population-wide outcomes in the form of incidence rates or averaged measures, represents an approach to population-level measurement that is rooted within a utilitarian paradigm. Viewing the community as a collection of individuals, utilitarians seek the greatest good to the greatest number of individuals. Thus, the unit of analysis remains the individual, where individual outcomes are summed to produce a population 'score', with the goal of increasing the overall 'good' (health) in the population.

However, this view of community as nothing more than a collection of individuals is a rather limited one, which does not take into account important community-level issues such as distributive justice, or equity, which has become an increasingly important focus in public health.[21] Discourse on equity in public health tends to centre around the social justice philosophy of John Rawls, who proposed a modified version of social contract theory.[22] His view of justice involves the construction of a social system to which all society submits, given that each is willing to accept the least privileged position within that system. Thus, it is in everyone's best interest to construct a system which is as equitable as possible. The implication for population health measurement is a focus on the distribution of health, rather than the average 'amount' of health within the population. Concepts such as 'equity' and 'social justice' are population-wide phenomena, not measured at the individual level.

Population-wide phenomena are also a focus of the community development literature, which stresses the importance of collective perceptions, actions, and environment in how a community understands itself and responds to challenges.[23] This organic or holistic view of community is not valued in a strictly utilitarian framework. The utilitarian approach retains characteristics of health 'in' the community, while distributive justice and the community development approach are more oriented toward health 'of' the community.

These distinctions are illustrated in Morgenstern's classification of ecologic indicators.[24] He proposes three categories or levels for community health indicators: aggregate, environmental and global.

Aggregate indicators are by far the most common in population health measurement. Based on the combination of individual level observations, these indicators can be aggregated to community, regional, provincial, or national levels. Lung cancer mortality rate, proportion of smokers, and average income are all examples of aggregate indicators. These indicators tend to be more related to health 'in' the community, appropriate to a utilitarian approach.

Environmental indicators are, to use Morgenstern's words, "physical characteristics of the place in which members of each group live or work." Each environmental indicator, measured at a group level, has an analogue at the individual level. Measures such as air quality are generally measured for a large area, but can theoretically be measured for each individual. In addition, one would expect (perhaps considerable) variation in the quality of respired air between individuals within the population. However, unlike aggregate indicators, environmental indicators focus on factors external to the individuals within the community. While environmental data can be collected at a number of levels, the data at one level are not generally derived from data at lower levels as with the aggregate indicators. Air quality, for example, is not the sum of individual exposures within a community, but is represented by measures at a particular level (for example, household air quality, factory emissions, or ambient air quality) which do not necessarily translate directly into measures at another level.

Global indicators apply to populations as a whole with no obvious analogue at the individual level. As such, they reflect health 'of' the community. Measures such as the existence of a particular law or policy do not make use of individual data. A law either exists or does not exist and applies to a defined group of people. A provincial law applies to the province as a whole. One cannot choose the level at which the indicator will be measured. The extent of green space in the community is one global indicator in the OCHP. These indicators are much less common in current community health profiles, but would also include measures of 'healthy public policy' or government spending on particular programmes. Equality (or inequality) in health fits the description of a global indicator, but makes use of individual level data. Equality has no obvious analogue at the individual level, and appears to be measuring some 'emergent property' or phenomenon which is greater than the sum of its component parts. Thus, global indicators are relevant to community development and distributive justice perspectives in community health.

In summary, community health measurement should encompass population-level phenomena (health 'of' the community) as well as the more commonly measured individual-level phenomena (health 'in' the community). As with the definition of health, these perspectives lie on a continuum, from individual-oriented measures derived from clinical statistics to indicators of population-level phenomena such as policy and legislation (Figure 1.2).

Figure 1.2 ***Examples of indicators placed along the continuum between health 'in' and health 'of' the community***

A Framework for Evaluating Community Health Profiles

This chapter has identified two components to the definition of community health -- a definition of health and a definition of community. Each component appears to describe an axis along which community health indicators can be classified (as illustrated in Figures 1.1 and 1.2). Combining these two components as orthogonal axes results in a framework that has some utility in illustrating the contrasts between approaches to community health practice and measurement (Figure 1.3). The following section describes historical paradigms in epidemiology and current approaches to community health, showing how these fit within the proposed framework. In Chapter 3, the OCHP indicators are mapped onto these axes to illustrate the relevance of the OCHP.

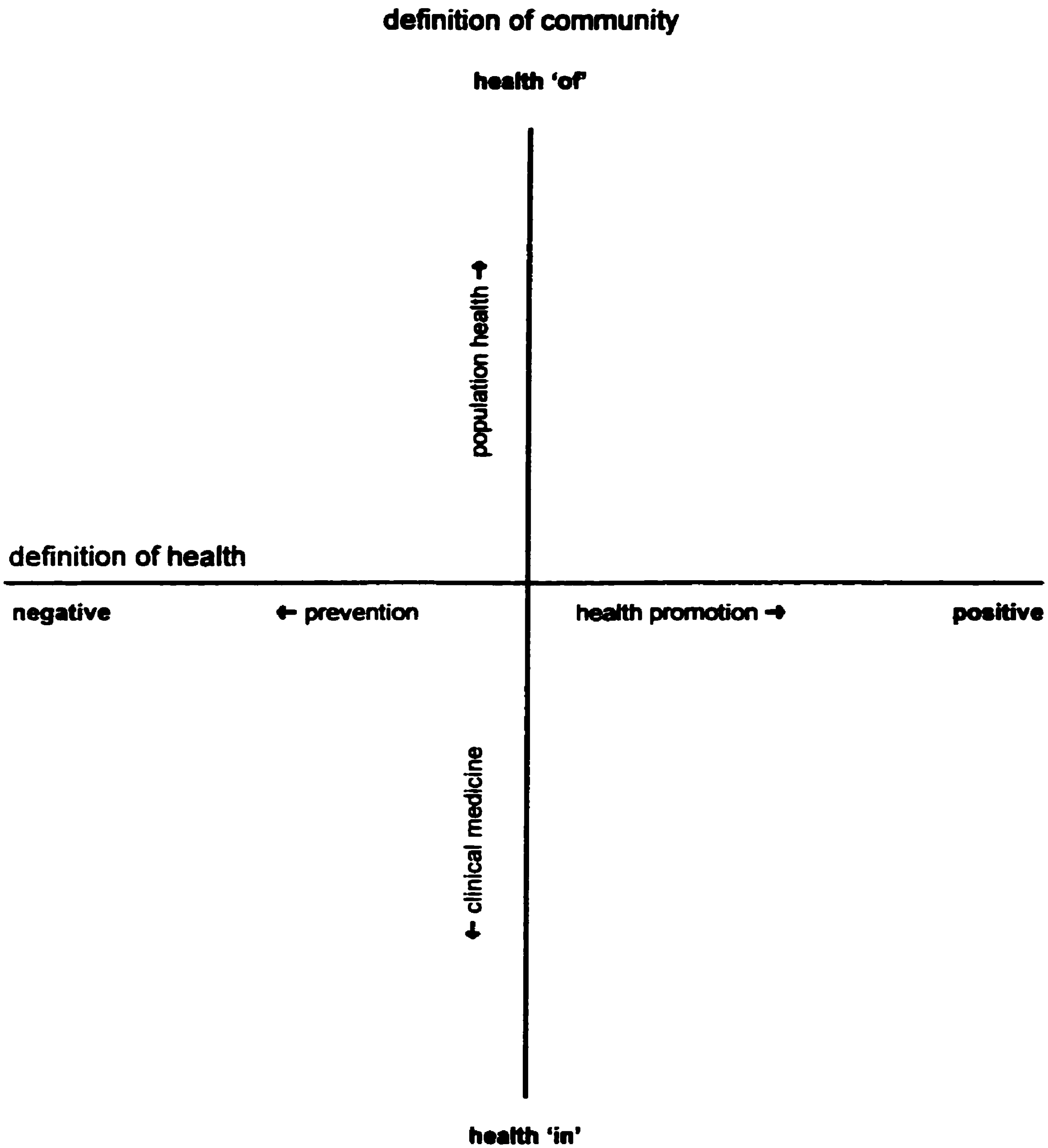


Figure 1.3 Proposed framework for mapping community health profiles

Dynamics of Community Health: Paradigms and Approaches

This section begins with a description of evolving public health paradigms, and then presents some current approaches to public health in terms of their perspectives on the definition and dynamics of community health.

Changing Paradigms

> "Epidemiology has become a set of generic methods for *measuring* associations of exposure and disease in individuals, rather than functioning as part of a multidisciplinary approach to *understanding* the causation of disease in populations."
> – Pearce 1996

Examining the history of epidemiology provides some helpful insights into our current philosophical framework and analytical methods. Contrasting 'traditional epidemiology' and 'modern epidemiology', Pearce laments a shift from a population focus to an individual or sub-individual focus which has removed epidemiology from its original roots in public health.[25] Susser also describes a shift away from traditional public health, identifying four eras in epidemiological history, each with a different paradigm.[26]

1. Sanitary Statistics and Miasma:

Susser begins with the era of sanitary statistics and its paradigm of 'miasma'. Researchers looked at clusters of undifferentiated morbidity or mortality and proposed environmental solutions to try to eliminate the 'foul emanations' responsible for disease. Within this paradigm, general associations of population-wide outcomes and population-wide influences were emphasized with little or no focus on underlying biological or sociological mechanisms.

2. Infectious Disease and Germ Theory:

Following this in Susser's description is the era of infectious disease which is characterized by germ theory. With the discovery of microbial agents, research became highly reductionist, focusing on interventions at the individual level (vaccines, antibiotics) to reduce the risk of disease. Pearce refers to this as the 'bottom up' approach to public health in which we seek to understand the dynamics of disease in populations through analysis at the level of the lowest common denominator — here the individual or even sub-individual level (as in genetic and molecular epidemiology). There is an assumption of universalism here; in other words, that relationships at microscopic levels also hold at macroscopic levels. Within this paradigm, the broader influences on health such as social or economic factors are seen as irrelevant. Germ theory and the miasma paradigm are at opposite ends of the spectrum of public health paradigms.

3. Chronic Disease and the Black Box:

Third is the current era of chronic disease in which the "black box" forms the prevailing paradigm. Given our limited understanding of causal pathways for outcomes such as cancer or cardiovascular disease, the research focuses on factors affecting individual outcomes but takes into account various areas of lifestyle, environment, and individual agent in the etiology of disease. While we know that many factors are involved, we do not understand how they interrelate, and so treat them as a "black box." In seeking associations between factors and outcomes, without attempting a comprehensive analysis of underlying processes, the black box paradigm bears a resemblance to the miasma paradigm. In seeking to explain risks to individuals within the population (as with activities such as Health Risk Appraisal), rather than the dynamics of incidence rates, it retains the micro-level emphasis of germ theory.

4. Eco-epidemiology and Chinese Boxes:

Susser argues that we are now moving toward a new era characterized by a paradigm of 'Chinese boxes -- a conjurer's nest of boxes, each containing a succession of smaller ones.'[27] Here, the complexity of community health is acknowledged in the rise of 'eco-epidemiology' which abandons the reductionist ideal of a grand unified theory of health (a set of rules with which we can predict outcomes at all levels). Instead it seeks an understanding of the interaction of systems and sensitivity to social, political, and economic contexts. Pearce also stresses the importance of contextualizing health research, incorporating wider population-level factors without sacrificing the methodological advances that have arisen from the modern epidemiological framework. This is a challenge both to the generalizability of epidemiological studies and to the comparability of community health assessments. This paradigm suggests the need to select indicators at various levels in Morgenstern's classification: aggregate, environmental and global.

Approaches to Community Health Practice and Measurement

The following discussion of general approaches to community health practice and measurement illustrates the preceding descriptions and the utility of the community health framework for representing a variety of community health perspectives. These approaches do not reflect a particular nomenclature in the literature, nor are they an exhaustive inventory of community health measurement; rather, they are described here as examples of a range of definitions of 'community' and 'health'.

Clinical, Biomedical Approach

Clinically and biomedically oriented approaches tend toward Susser's 'germ theory' or 'black box' paradigms, where intervention is aimed at an individual level. Health 'in' the community is the outcome of interest, and the definition of health is focused on disease-related states. Health care services and screening programmes are common examples of the clinical, biomedical approach. Areas of epidemiology which aim to identify risks for disease-related outcomes are also included here. Participation in screening programmes and use of health services, as well as morbidity and mortality rates such as cardiovascular disease mortality or cancer incidence, are examples of indicators that would fit this approach.

Health Protection Approach

As defined here, health protection approaches fit within Susser's 'miasma' paradigm, where population-level outcomes are linked with population-level exposures, but the focus is largely on negative health (disease-related) outcomes. Restaurant inspection is one common example of this approach. In addition to activities such as health protection and environmental health research, recent studies of equity in morbidity/mortality outcomes (mainly in Europe) incorporate aspects of a preventive or health protection approach. This could also include the work of people like Geoffrey Rose in developing a population health perspective for disease outcomes (e.g. CVD). In epidemiology, ecological studies of disease patterns are a general example of a health protection approach. Examples of indicators here would include environmental variables such as air quality and water quality, as well as associated morbidity/mortality statistics (cancer rates, infectious disease rates etc).

Quality of Life Approach

Quality of life (QOL) approaches emphasize individual-level, positive health outcomes. Seniors' mall-walking programmes or yoga classes are examples of this approach in some health units. Measurement of functional and subjective health status in individuals are QOL-oriented approaches. Ideas such as 'supportive environments for health'[10] and health as self-actualization *within* communities take us in the direction of QOL approaches. Here, the definition of health is broadened, but the focus remains on health 'in' the community. Indicators include functional restrictions, self-perceived health and social support.

Community Development Approach

Positive health 'of' the community is emphasized in community development approaches. The focus is on building 'healthy communities' by encouraging interaction and action at the local level. Community gardens and Child-to-Child programmes are two current examples of this approach in Ottawa community health centres. John McKnight speaks of 'mobilizing community assets,'[23] arguing that when a community comes together, there is a collective vision and agency which exceeds the sum of its parts. Much has been written recently on issues of 'empowerment' and community health.[28] Health is viewed as a process of communities taking control of their own environmental, sociological, physical and spiritual well-being. The language is of 'mutual influence', 'shared needs' and 'membership.'[29] Methods involve participatory research and education. The rhetoric of public health is moving in the direction of community health, which may parallel Susser's view of a move toward 'eco-epidemiology' and the paradigm of 'Chinese boxes'. However, the reality of measurement lags behind, given the difficulty of operationalizing many of the concepts.

Ecosystem Health Approach

As with the community development model, ecosystem health approaches use a positive definition of health at the community level. They have been included here as a separate category due to their broader definition of community. Here, 'community' refers not only to human communities as in the community development approaches, but to bio-regions as a whole. This is perhaps the clearest example of what Susser refers to as 'eco-epidemiology'. Emphasis is placed on interactions and processes within systems. However, as with the community development approaches, operationalization of concepts lags behind the rhetoric.

Each of the preceding approaches can be placed within a quadrant of the community health framework (Figure 1.4). This is not to say that the quadrants are neatly defined by each approach. Rather, the approaches represent directions of movement within each quadrant. Thus, models of health which tend toward health 'in' the community and a disease focus are oriented toward the clinical, biomedical approach, but are not necessarily entirely classified as such. Mapping a set of indicators onto these axes, as described in Chapter 3, provides insight into the main paradigm and approach underlying the development of a given profile.

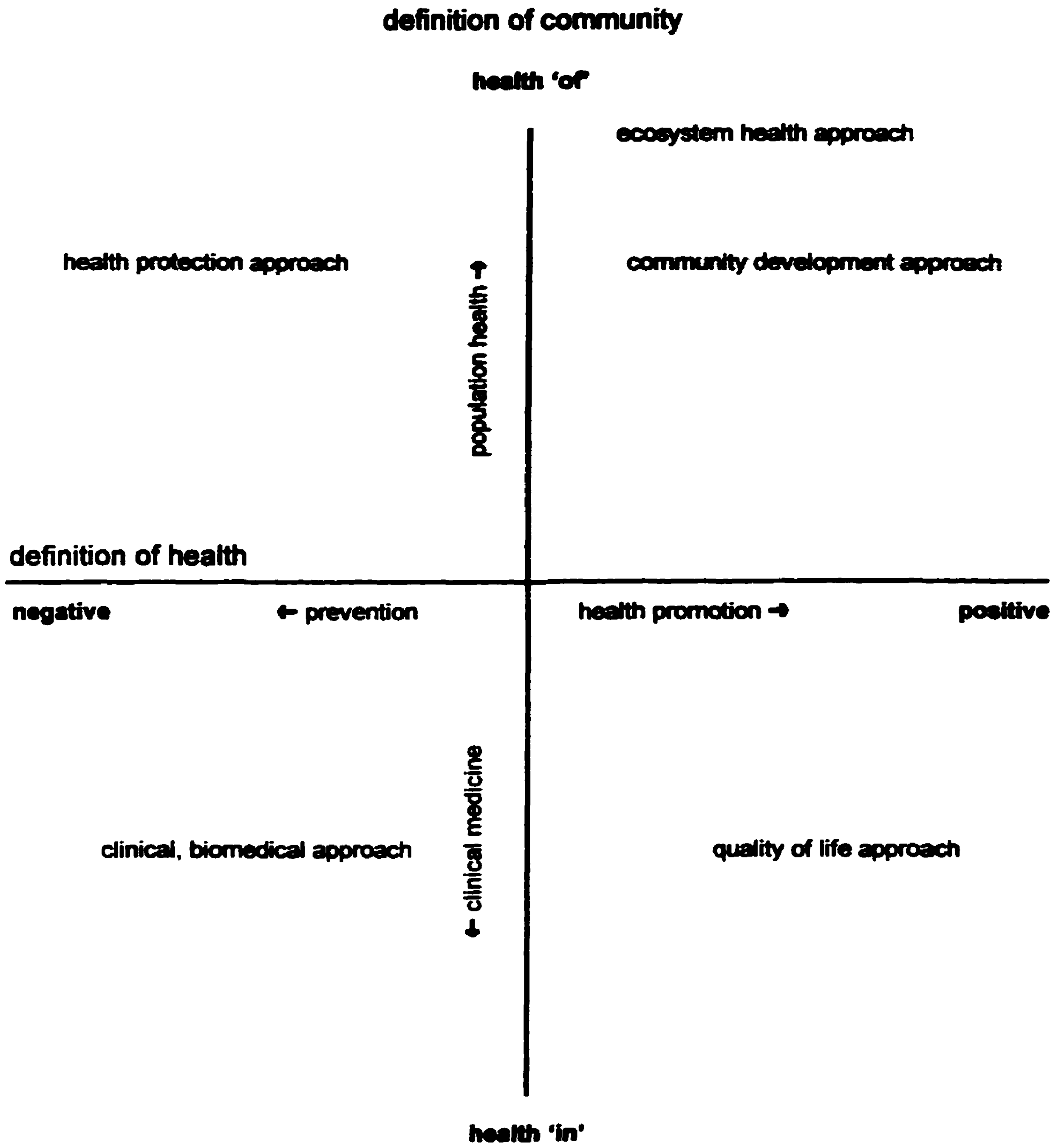


Figure 1.4 ***Community health approaches mapped on the proposed orthogonal community health axes***

Population Health, Health Promotion, and Population Health Promotion

This framework is also helpful in better understanding the roles of population health and health promotion approaches. In many cases, these two approaches have been perceived as opposing camps, with incompatible goals.[30] Health promotion, rooted in the Lalonde and Epp reports as well as the Ottawa Charter, with its emphasis on capacity, empowerment and support has been criticized for setting unrealistic goals and being unable to measure its impact in or on the population. Population health, primarily as articulated by the Canadian Institute for Advanced Research (CIAR), has been criticized for its shallow critique of social forces, and for appearing to support the economic growth models of neo-conservative policy.[31]

There have been efforts to unite the two perspectives in a common framework; one of the most notable being Hamilton and Bhatti's paper on Population Health Promotion which presents a series of cubes formed by the intersection of three dimensions: who is affected (population, group, individual), what area of health is of concern, and how to achieve change (action or method).[32] Similarly, I do not wish to view population health and health promotion as two solitudes, but rather would like to draw on the strengths of each in forming an understanding of community health measurement.

At the risk of oversimplifying the argument, I suggest that we place the primary focus of each approach on the framework's orthogonal axes. Population health approaches appear to be primarily concerned with moving the definition of community along the vertical axis toward health 'of' the community (moving from high-risk to population-wide interventions), while health promotion is more concerned with moving the definition of health along the horizontal axis toward more positive definitions of health. We can assess the population perspective of any given framework according to its position along the community axis, and the health promotion perspective according to its position along the health axis. Population health promotion could then be defined as an approach which addresses positive health 'of' the community.

Conclusion

This chapter has defined community health in terms of its components 'community' and 'health.' Combining these two components as orthogonal axes creates a framework within which a variety of approaches to community health may be identified. The framework is also helpful in understanding the relationship between population health and health promotion. This framework forms the basis for evaluating the comprehensiveness of the OCHP in Chapter 3. Chapter 2 describes a specific set of criteria for evaluating community health profiles.

Chapter 2

Criteria used to Assess the OCHP and Background to the Analyses

Assessment of the Ontario Community Health Profile: Criteria

In order to determine whether the Ontario Community Health Profile can be used to assess community health as defined in Chapter 1, it must first meet certain criteria. Numerous criteria for the assessment of indicators are suggested in the literature. Various projects have employed a range of standards in choosing measures of community health. In reviewing these projects, there appear to be three central questions in the selection of community health indicators:

1. How **relevant** are the indicators to our understanding of community health?
2. How **representative** are indicators of the community and the individuals within the community?
3. How **practical** are the indicators and the profile as a whole?

Each of these questions is addressed in the following chapters. There are specific criteria for each question which are discussed in more detail in Chapters 3-5. For each specific criterion discussed, a specific evaluation question is proposed and tested. The remainder of this chapter provides additional information as background to the analyses which follow. First, the indicators that make up the Ontario Community Health Profile are presented. This is followed by a discussion of the data sources and geographic classifications used.

Indicators in the Ontario Community Health Profile

As mentioned in the introduction to this report, the Ontario Community Health Profile contains 66 indicators in six categories: demographic, economic, social, physical, health-related practices and health status. Table 2.1 presents the complete listing of indicators by category.

Table 2.1 Ontario Community Health Profile: categories and indicators

Category	Indicator
A. Demographic	1. population by age and sex
	2. population growth rate
	3. population projections
	4. age-specific fertility rate
	5. total fertility rate
	6. therapeutic abortion ratio
	7. population by ethnic origin
	8. population by home language
	9. proportion of single-parent families
	10. population density
	11. proportion of seniors living alone
B. Economic	1. education level of population 15 and over
	2. proportion of population living below the low income cut-off point
	3. proportion of population receiving social assistance
	4. average employment income
	5. dwellings needing major repairs
	6. owner-occupied dwellings
	7. percentage of households paying 30% or more of household income on housing
	8. subsidized rental accomodation
	9. number of people receiving food from a food bank
	10. unemployment rate
C. Social	1. average number of persons per room
	2. adult literacy rate
	3. violent crime rate
	4. proportion of population reporting dysfunctional family relationship
	5. voter participation rate
	6. volunteer participation
	7. proportion of population very satisfied with their social life
	8. well-being index

Category	Indicator
D. Physical Environment	1. number of hours of moderate/poor air quality
	2. frequency of poor water quality
	3. public green space
	4. seasonal closing of beaches
	5. ultraviolet index
E. Health-Related Practices	1. proportion of current cigarette smokers
	2. proportion of population consuming 15 or more alcoholic drinks per week
	3. population distribution of binge drinking
	4. prevalence of overweight
	5. fat as percentage of energy
	6. population distribution of physical activity
	7. use of condoms as protection from STDs
	8. cervical cancer screening
	9. breast cancer screening
	10. proportion of population wearing seat belts
	11. bicycle helmet use
F. Health Status	1. life expectancy
	2. rate of low birth weight
	3. proportion of population in fair or poor perceived health
	4. chronic health problems
	5. leading causes of death
	6. infant mortality rate
	7. perinatal mortality rate
	8. suicide rate
	9. proportion of population having contemplated suicide
	10. motor vehicle injury mortality rate
	11. potential years of life lost
	12. leading causes of hospital separations
	13. cancer incidence
	14. hospital morbidity due to injury
	15. leading causes of hospital days of stay
	16. incidence of major notifiable diseases

Category	Indicator
F. Health Status (con't)	17. incidence of notifiable diseases requiring vaccination
	18. immunization status
	19. incidence of occupational injuries declared and compensated
	20. dental index
	21. prevalence of long-term disability

Data Sources

Data for the empirical analysis are drawn largely from the HELPS data set. HELPS was begun as a partnership between the Public Health Branch's Population Health Service and health units in Ontario. The project aims to increase the health measurement capacity of health units by providing data, software and access to epidemiologic resources. At present, the data set contains information from seven databases:

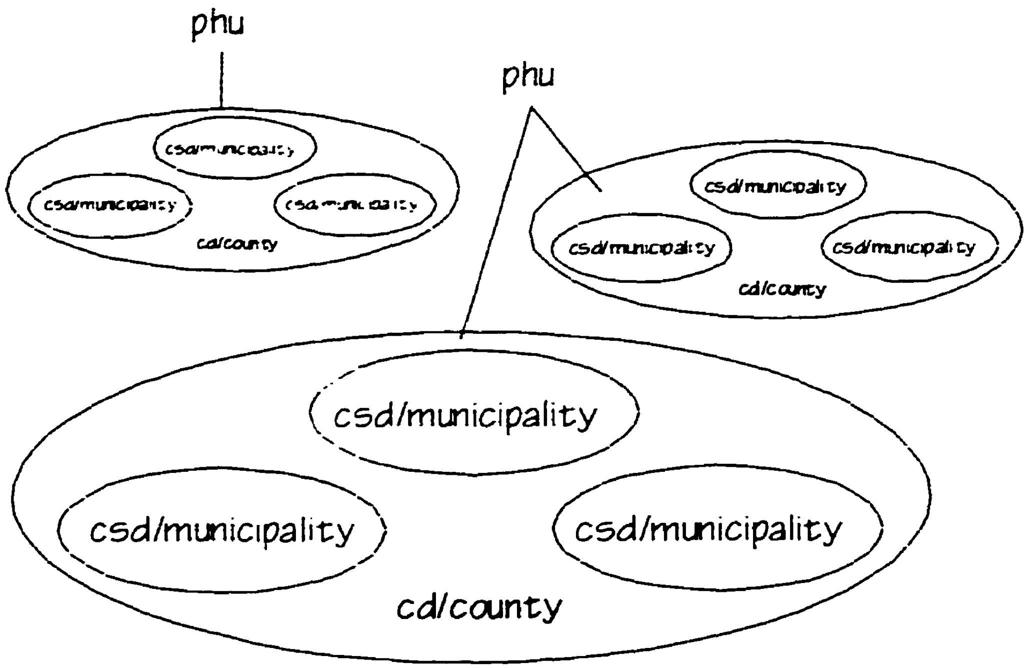
- Ontario Cancer Incidence
- Ontario Health Survey
- Ontario Mortality Database
- Ontario Livebirth Database
- Ontario Stillbirth Database
- Ontario Population Database
- Ontario Population Projections

Data were obtained from these sources through the Health Information Partnership for Eastern Ontario, with the permission of the Public Health Branch, Ontario Ministry of Health. All indicator calculations and analyses were performed in SPSS Version 7.

Geographic Classifications

Two main levels of aggregation are commonly used for health information in Ontario: the county and the municipality. Health units generally represent a county or group of counties (for example, the combined counties of Leeds, Grenville and Lanark). Each county contains many municipalities. Within the province, three main coding systems are used in data collection: census codes (census divisions and subdivisions), provincial geocodes, and public health unit (PHU) codes. The hierarchy of geographic classifications is illustrated in Figure 2.1

Figure 2.1 ***An illustration of the links between census subdivisions (CSD)/municipalities, census divisions (CD)/counties, and public health units (PHU)***



The census subdivision (CSD) represents a municipality or equivalents such as Indian reserves, Indian settlements or unorganized territories.[33] The 1991 census enumerated 951 CSDs in Ontario, of which 791 were villages, towns, townships, cities, or boroughs. It is important to note that large metropolitan areas such as Toronto, Ottawa, and Kingston are coded as Census Metropolitan Areas (CMAs) which contain a number of CSDs, and may extend across two or more CDs or even two provinces, as in Ottawa-Hull. Of the remaining CSDs, 128 were reserves, nine were Indian settlements, 20 were unorganized territories, and three were improvement districts. The CSD is generally the lowest level of aggregation at which centrally provided data are available.

The census division (CD) is a collection of CSDs which, in Ontario, represent a county, district, district municipality, metropolitan municipality, regional municipality, or united counties. To give an example, the Regional Municipality of Ottawa-Carleton is a census division, while the cities of Ottawa, Vanier and Rockcliffe Park are three census subdivisions within that census division. There are 60 CDs in Ontario.

Some health data are also coded by provincial geocode. This is a coding system used to identify counties and municipalities. Thus, it is analogous to the federal system of census divisions and subdivisions, with a few key differences. There are 70 separate geocodes in Ontario, but these include summary codes (for example, geocode 58 is the provincial total). Also, there are provincial geocodes for each of the (recently deceased) municipalities in Metropolitan Toronto. While all of Metro is one CD, each of these municipalities was a health unit when these data were collected in 1991.

With the exception of the municipalities in Toronto, health units represent a county or group of counties. There were 42 health units in Ontario at the time of the 1990 Ontario

Health Survey (OHS).

The databases used for HELPS variously use all three coding systems. This complicates comparisons of data from two or more different databases within the system. For the following analyses, all codes were converted to PHU codes. Thus, all data aggregated by census division, provincial geocode or health unit are considered to be available at the PHU level. This leaves us with two main sub-provincial levels of disaggregation: the 42 PHUs and their member municipalities (CSDs).

Calculation of the Health Status Indicators

Table 2.2 describes the calculation and data source for each of the health status indicators used in the analyses.

Table 2.2 Calculation of the Ontario Community Health Profile Health Status Indicators

indicator	formula used in calculation	data sources	
		numerator	denominator
life expectancy at birth	Life Table Method	1991 mortality registry	1991 census
low birth weight (LBW)	$\frac{\textit{births under 2500g}}{\textit{total live births}} \times 100$	1991 live birth registry	1991 live birth registry
% in fair or poor self-perceived health	$\frac{\textit{reported fair/poor health}}{\textit{total population}} \times \textit{OHS wt}$	1990 OHS	1991 census
% chronic health problems	$\frac{\textit{reported} \geq 1 \textit{ chronic health problems}}{\textit{total population}} \times \textit{OHS wt}$	1990 OHS	1991 census
crude mortality rate: all causes (CMR)	$\frac{\textit{total deaths (all causes)}}{\textit{total population}} \times 1000$	1991 mortality registry	1991 census
infant mortality rate	$\frac{\textit{total deaths } 0\text{-}1 \textit{ years}}{\textit{total livebirths}} \times 1000$	1991 mortality registry	1991 livebirth registry
perinatal mortality rate	$\frac{\textit{stillbirths + early neonatal deaths*}}{\textit{total livebirths + stillbirths}} \times 1000$	1991 mortality registry, 1991 stillbirth registry	1991 livebirth registry, 1991 stillbirth registry
suicide rate	$\frac{\textit{suicide deaths}}{\textit{total population}} \times 1000$	1991 mortality registry	1991 census
contemplated suicide	$\frac{\textit{contemplated suicide}}{\textit{total population}} \times \textit{OHS wt}$	1990 OHS	1991 census
motor vehicle accident mortality (MVA)	$\frac{\textit{MVA deaths}}{\textit{total population}} \times 1000$	1991 mortality registry	1991 census
potential years of life lost (PYLL)	$\frac{\Sigma\ (\textit{age spec deaths} \times (70 - \textit{avg age}))}{\textit{total population under } 70} \times 1000$	1991 mortality registry	1991 census
hospital separations: psychoses, pneumonia, complications of pregnancy, IHD, falls	$\frac{\textit{total cause-spec hosp separations}}{\textit{total population}} \times 100{,}000$	CIHI	1991 census
hospital morbidity: injury	$\frac{\textit{total hosp separations: injury}}{\textit{total population}} \times 100{,}000$	CIHI	1991 census
hospital days of stay: psychoses, pneumonia, complications of pregnancy, IHD	$\frac{\textit{total cause-spec hosp days}}{\textit{total population}} \times 1000$	CIHI	1991 census
prevalence of long-term disability	$\frac{\textit{total reported disability}}{\textit{total population}} \times \textit{OHS wt}$	1990 OHS	1991 census

Summary 1991 numerator values were available from HELPS by cause and CD for registry data (mortality and hospital morbidity). After conversion from CD codes to PHU codes, cause-specific and all-cause mortality and morbidity rates were calculated simply by dividing the number of cases by the census population in each PHU. Age-specific data were available, from which age-specific death rates, potential years of life lost, infant mortality, and life expectancies were calculated.

1990 OHS responses were available as record-level data for each respondent. Each entry has been given a weight based on the number of individuals it represents in the sampling design. In general, the OHS aimed to complete 1000 questionnaires in each health unit. Data were aggregated by PHU and sex, using the weighting feature in SPSS to calculate representative estimates for each of the OHS-based OCHP variables. These estimates were then divided by census populations to calculate rates for each PHU.

Annual registry data for the six PHUs in Eastern Ontario were available at the record level. The mortality registry, live birth and stillbirth databases provided data for the infant and perinatal mortality rates, as well as the rate of low birth weight. To calculate CSD rates, these data were aggregated to the CSD level and divided by the census population in each CSD. Given the low numbers of cases at this level of aggregation, the data were combined for five years (1989-1993) in each CSD. Using the 1991 census as a denominator introduces some error here as many populations would not have had stable populations throughout the five year time period. I have tried to reduce the error by centring the five year period around the 1991 census. This still assumes a linear growth or reduction in population numbers -- likely untrue in many CSDs -- but does reduce the error due to changing populations.

Indicators not included in the analyses

Certain health status indicators were not available or did not appear to be appropriate to the empirical analyses. Cancer data from the Health Information Partnership for Eastern Ontario cover only the six Eastern Ontario PHUs. Immunization data were not available through the HELPS data sets. Information on the incidence of occupational injuries is also not included in the HELPS database and is only available on a provincial level.

Data on notifiable diseases were also not included in the analyses. These indicators are generally used to give warning of possible outbreaks and to identify high risk areas. The appearance of case clusters alerts public health officials to a potential problem area. Thus, the purpose of the indicators is more one of screening than of measuring some underlying concept of community health and comparing across health units.

The DMF Index (teeth decayed, missing and filled) is generally available from the Public Health Branch, but problems with computer archives at the Ministry meant that sub-provincial data for this indicator were only available through local health units. Currently the dental survey is being altered to focus only on junior and senior kindergarten students, whereas past surveys have focused on odd-year aged children throughout public school (at two year and, in recent years, four year intervals). The Ministry appears to be making the index more a screening tool than a community health indicator (an example of an indicator focused at the individual rather than community level). Given the problems with data retrieval and the changing nature of this indicator, it was not included in the empirical analyses.

Using the criteria, indicators and data sources described here, the next three chapters conceptually and empirically assess the degree to which the OCHP is relevant, representative and practical.

Chapter 3

Relevance of the Ontario Community Health Profile

'The government is very keen on amassing statistics. They collect them, add them, raise them to the n^{th} power, take the cube root and prepare wonderful diagrams. But you must never forget that every one of these figures comes in the first instance from the village watchman, who just puts down what he damn well pleases.'

- Sir Josiah Stamp, Inland Revenue Department, Great Britain, 1886-1919

Examining the relevance of the indicators to our understanding of community health is essentially an inquiry into the validity of the profile. Many types of validity have been described in the literature, including content validity, criterion validity and construct validity.[34] However, as Streiner and Norman suggest, these various categories of validity share a common theme: the confidence with which inferences can be drawn about a population using a given measure. The basic question of validity to be addressed here is how much confidence can be placed in the inferences drawn about the communities in Ontario public health units from the Ontario Community Health Profile. This depends on how well the indicators in the profile reflect the concept of community health outlined in Chapter 1.

Community health fits the definition of a 'construct.'. That is, it is a 'mini-theory' which is not directly observable but has a number of observable manifestations.[34] In this case, the hypothesized manifestations are the various indicators that purport to measure some aspect of community health. Construct validity differs from criterion validity, where a 'gold-standard' exists and can be used to evaluate the validity of other tests or measures. Here, there are no gold-standards and, as described in Chapter 1, there are often sharply divergent opinions on what constitutes community health. Given the difficulties of finding agreed definitions, construct validity testing of community health profiles has generally tested little more than face validity as determined by a panel that selects indicators based on their apparent relevance to community health. However, the perceived relevance of various indicators will differ, depending on who sits on the panel.

Hancock states that, in order to stimulate action and change, indicators must carry social and political "punch". That is, they must be relevant to the various groups who will use them. This requires an awareness of who will use the indicators and why.[35] Ideally, for maximum political and social impact, indicators are meaningful across a range of groups.[36] Three main sets of users identified in the literature are community members (the public or local level) who desire information that is accessible, framed in common language, and responsive to community concerns; the political level, including pressure groups, policy makers and politicians who desire information at an intermediate level of complexity with clear links to legislative or economic decision-making; and the professional level of academics and health practitioners, planners and epidemiologists who seek information that is often at a more complex level with a focus on validity, reliability, and sensitivity.[37] In many cases, this last group has guided the selection of indicators for community health profiles. Even here, there are diverse perspectives, depending on each participant's academic, professional and personal background.

Often, community perceptions of health may differ quite significantly from professional or political perceptions. One major challenge is to better involve community members in the selection of appropriate indicators. Nord *et al.* surveyed communities in Australia on the importance of equity as a component of community health.[38] However, the survey approach to learning about community attitudes and perceptions is only a starting point. Rapid epidemiologic assessment in the developing world has done more to build community participation into the measurement process. CIETinternational, a non-governmental organization which does consulting work in health assessment, has developed an approach which combines quantitative and qualitative approaches to better incorporate community perceptions in community health evaluations.[36] Other initiatives in Ontario, such as Healthy Cities projects, have also attempted to make community health assessment a community-led exercise.

The Ontario Community Health Profile arose largely from the CHIS profile and discussions within the Ministry of Health and Public Health Units as part of the Community Health Framework Project. Thus, consultations with other stakeholders and community members has been limited. It would be appropriate to provide community-level input into the process in future, assessing the face validity of the indicators within the profile. This could involve community consultations in selected areas to determine the appropriateness and relevance of the indicators. Such an assessment is beyond the scope of this thesis.

Instead, validity of the profile as a whole is assessed using the framework for community health developed in Chapter 1. Indicators from the OCHP may be conceptually 'mapped' onto the framework, based on whether they appear to be oriented more toward positive or negative health, and health 'in' or health 'of' the community. The resulting diagram identifies biases toward particular components of community health and possible 'gaps' in the profile. In defining community health, the OCHP documentation cites a move away from disease oriented definitions of health, toward definitions that better reflect the Ottawa Charter's understanding of health as a 'resource' for daily living. In theory, it thus emphasizes 'personal and collective well-being' in addition to the more traditional morbidity and mortality outcomes. In addition, one of the OCHP goals, as outlined in the documentation, is to 'describe the health of the individuals in a community as well as the community itself.' This implies a sensitivity to health 'in' and health 'of' the community. Whether the actual indicators are relevant to this theoretical orientation is the subject of this analysis. This is a conceptual exercise in face validity which could be used with a wider panel of judges who better represent a range of stakeholders and community members.

Evaluation Question #1: **How well do the OCHP indicators cover the community health framework?**

Methods

This section describes the Ontario Community Health Profile in terms of the two dimensions of the framework -- *definition of health* (positive/negative) and *level of community* (health 'in'/health 'of'). Each indicator of the profile has been mapped onto the framework based on where it lies on these two dimensions. These maps are intended to approximate the coverage of the community health concept afforded by the profile, given the indicators it uses.

Definition of Health (Positive versus Negative)

The health status indicators were grouped into categories, based on their orientation toward positive or negative health, in order to map them onto the community health framework. There are mortality-based measures (crude mortality rate, potential years of life lost, life expectancy, motor vehicle accident mortality rate, and suicide rate), hospital morbidity measures (days of stay, hospital separations and hospital separations for injury), community morbidity measures (dental index, notifiable disease, notifiable disease requiring vaccination, cancer rate and immunization rate), measures of infant health (infant mortality rate, perinatal mortality rate and incidence of low birth weight), chronic conditions (prevalence of chronic conditions, prevalence of disability, and occupational injury rate), and measures of self-perceived health (contemplated suicide and self-rated health). These categories were then placed along the horizontal axis 'definition of health.' Within each category, indicators were further ranked according to their relative tendency toward measuring positive or negative health states.

Level of Community (Health 'in' versus Health 'of')

A similar process was followed to rank indicators along the second dimension, 'level of community.' Here, indicators were ranked relative to Morgenstern's classification of aggregate, environmental and global indicators. Aggregate indicators were interpreted as being oriented toward health 'in' the community, while environmental and global measures are oriented toward health 'of' the community. As discussed in Chapter 1, global indicators were placed closer toward health 'of' the community than environmental indicators, given their association with community development and ecosystem health approaches, and the lack of an analogue at the individual level.

Mapping onto the Framework

Based on relative rankings according to definition of health and level of community, the OCHP indicators were mapped onto the community health framework defined in Chapter 1. Mapping indicators according to the two axes combined was intended to illustrate possible orientations of the profile toward a particular approach (biomedical, quality of life, community development etc.), to identify potential gaps within the profile, and to compare these parameters across various profiles.

For comparison, two other community health profiles -- the Manitoba Population Health Information System (PHIS) and the Canadian Health Information System (CHIS) --

and four theoretical models of community health have also been mapped onto the framework axes. These projects are described in greater detail in Appendix 1. The theoretical models include Evans & Stoddart[22] and the Canadian Institute for Advanced Research[39] models, which have been widely adopted by population health projects. The 'Butterfly Model' of community health proposed by the Agroecosystem Health Project[7] is less widely known, but is an interesting attempt to incorporate a more holistic view of health. Wolfson's POpulation HEalth Model (POHEM)[40] has been partially operationalized, but is presented here as a mainly theoretical model. More details on the degree to which that model has been operationalized are given in the appendix.

Results

Definition of Health

Figure 3.1 shows the ranking of health status indicators (top row), grouped according to the categories described above (middle row) placed along the 'definition of health' axis according to the reference categories defined in Figure 1.1. Indicators further to the right are more oriented toward positive health. As this is a ranking exercise, the focus is on the relative position of the indicators, not their exact distance along the axis.

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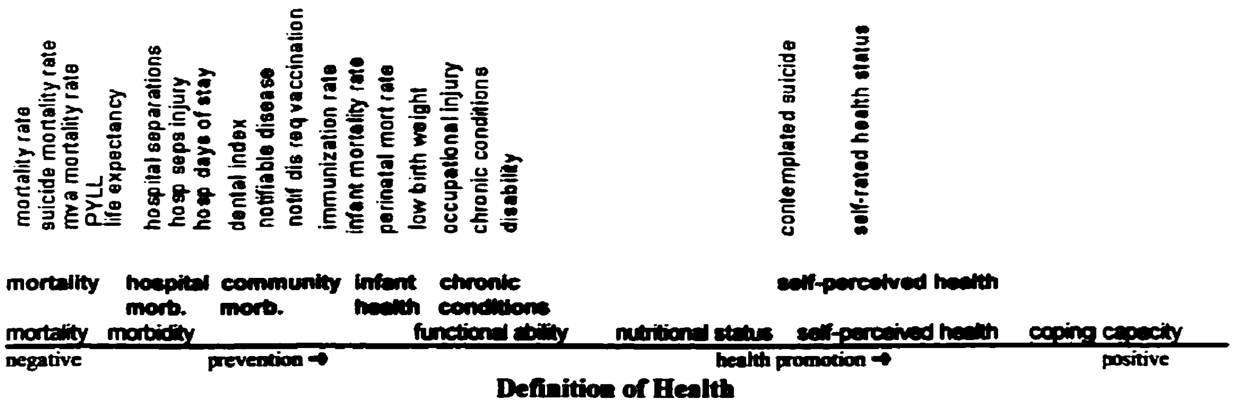


Figure 3.1 ***Health status indicators ranked along the 'definition of health' axis of the community health framework***

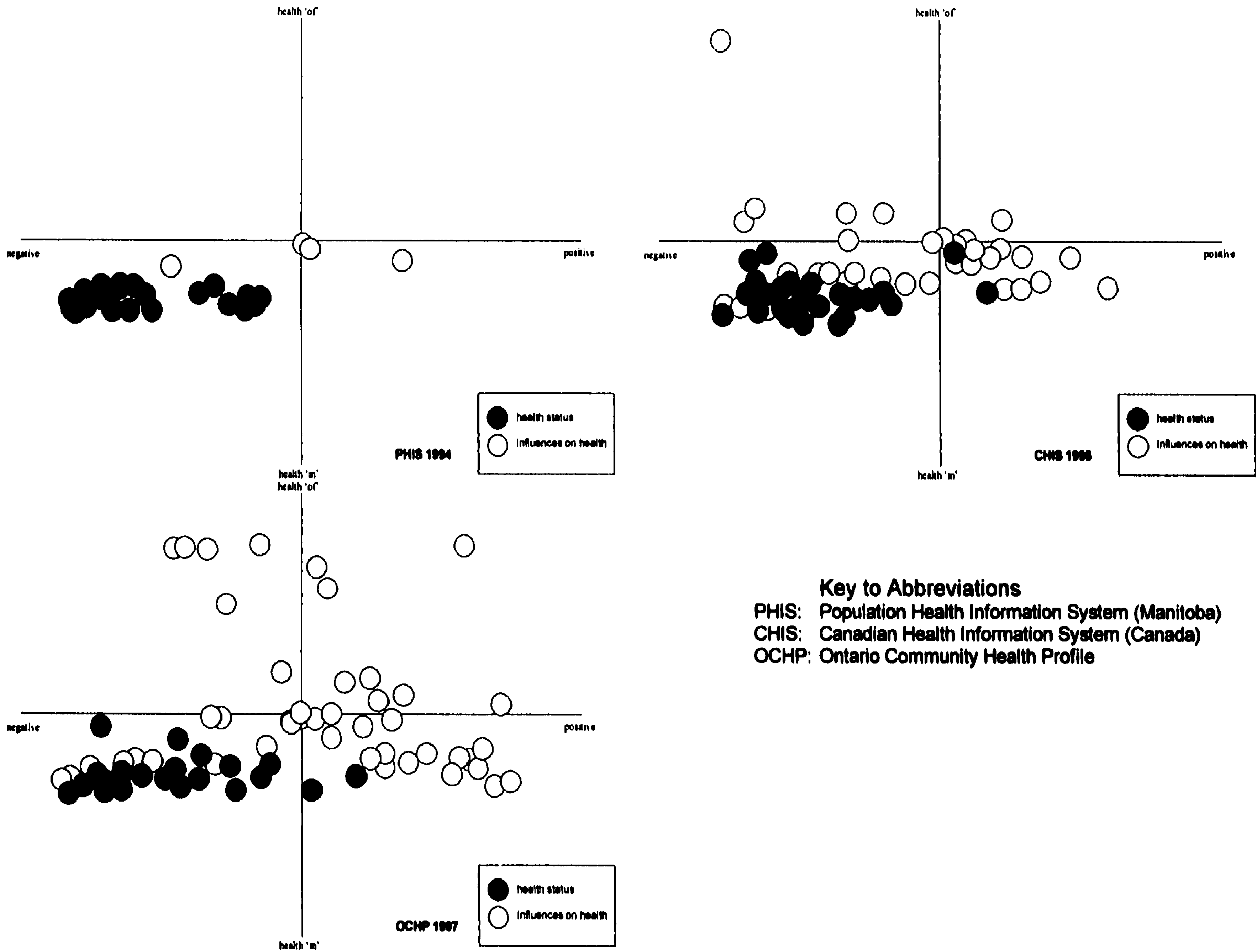
Level of Community

All of the health status indicators are aggregate indicators. The OCHP contains no environmental or global-level health status indicators. As described in Chapter 2, the dental index is being used more as a screening tool to detect individuals with dental problems, and thus is oriented more toward health 'in' the community than some of the other aggregate indicators that are intended primarily for use at the community level. However, there is little variation among the indicators according to the 'level of community' dimension, so no figure is provided.

Mapping onto the Framework

Figure 3.2 presents the indicators of the OCHP mapped onto the community health framework. The Canadian Health Information System and the Manitoba Population Health Information System profiles are also presented as conceptual maps for comparison. Light coloured dots represent indicators of influences on health while dark coloured dots represent health status indicators.

Figure 3.3 presents community health maps for the four theoretical community health models. As these models have not been operationalized, making it difficult to define more exact areas of measurement, their coverage of the community health framework is represented by shaded areas.



Key to Abbreviations

PHIS: Population Health Information System (Manitoba)
CHIS: Canadian Health Information System (Canada)
OCHP: Ontario Community Health Profile

***Figure 3.2** Conceptual maps of operationalized framework coverage, plotting indicators on the community health axes*

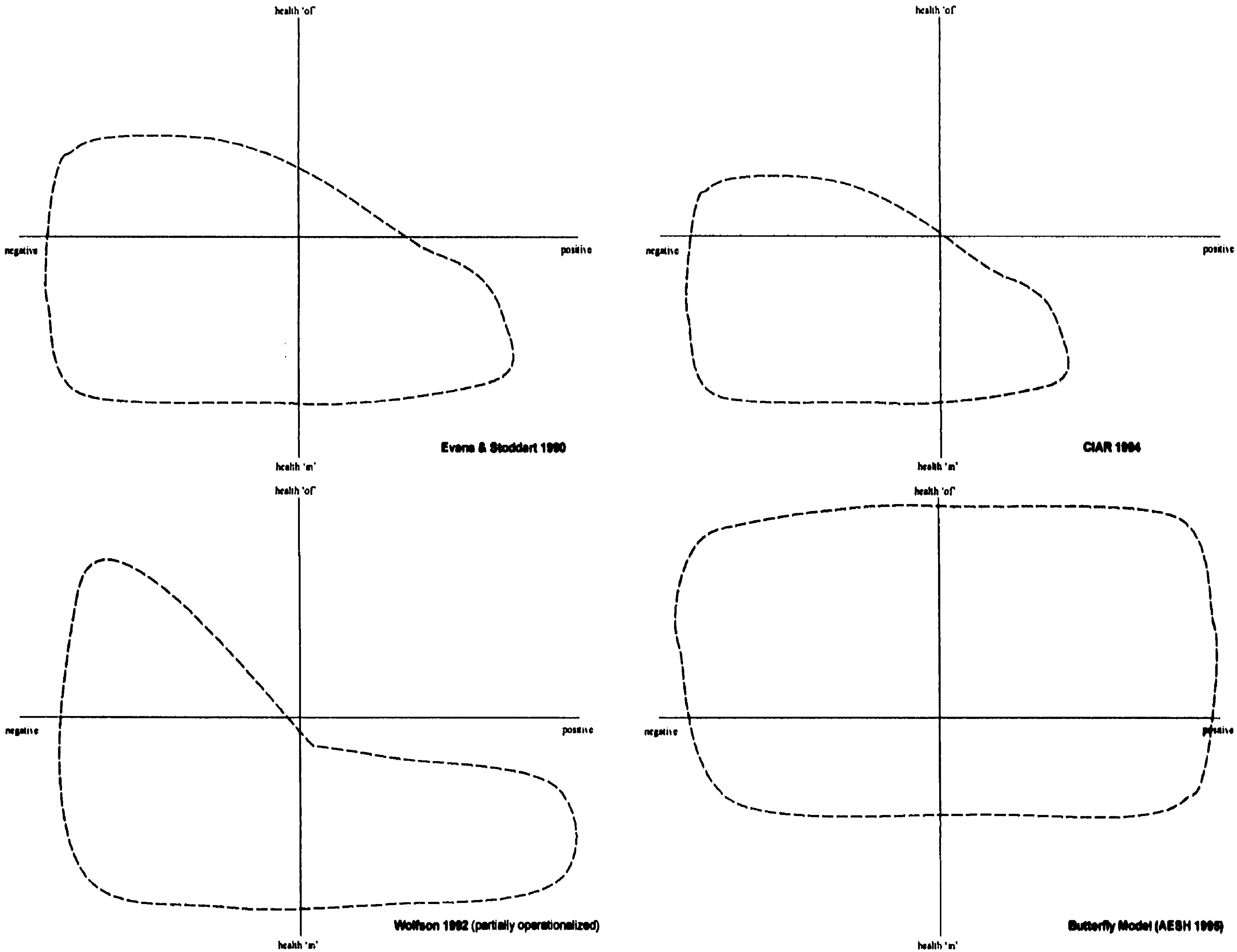


***Figure 3.3** Conceptual maps of theoretical community health frameworks using the community health axes*

Discussion

The map of the OCHP in Figure 3.2 reflects a largely biomedical approach to measuring health status. The OCHP incorporates a few positive measures of health, such as self-perceived health, but most health status measures remain focused on the lower left quadrant. As discussed in Chapter 1, this has been the general experience of community health profiles, given the difficulty of measuring positive health 'states' as opposed to the relative ease of defining negative health 'events.'

Certain aspects of the OCHP appear to be oriented toward more community level measurement. For example, the category of 'physical environment indicators,' contains some community level indicators which are not simply aggregations of individual data. Also, many of the social and economic indicators focus on housing and other factors which contribute to an environment conducive to health, in addition to the more individually-oriented lifestyle and behaviour measures. However, the category of 'health status' describes health 'in' rather than health 'of' the community. Among the health status indicators, there are none which would fit within Morgenstern's definition of environmental or global level indicators. As with many other models, community-level indicators are viewed as determinants of, or influences on, health, rather than health status itself.

Comparison with the maps of other community health models and profiles illustrates some interesting patterns. The operationalized models (PHIS, CHIS, OCHP) are oriented toward a clinical, biomedical approach in their selection of health status indicators. Theory has begun pushing toward ecosystem and community development approaches (as illustrated by the general shape of the maps for theoretical models in Figure 3.3), but the difficulties in operationalizing such models appear to pull actual profiles back toward negative health 'in' the community. The Manitoba Population Health Information System (PHIS) is a good example of this phenomenon. While theoretically based on the Canadian Institute for Advanced Research (CIAR) model, the operationalized PHIS is heavily biomedical in nature and also focused on the provision of health services — a factor which is very much downplayed in the CIAR and population health literature. The availability of a uniquely extensive and complete administrative database in the province is certainly a major reason for this apparent divergence. The POHEM appears to be more oriented toward positive health, but is only a partially operationalized model. As described in the review (Appendix 1), the operationalized portion of the template remains more biomedical in nature (focused on health-adjusted survival curves).

Another major element which seems to be lacking in the profiles is the concept of healthy public policy. While it is acknowledged in health promotion rhetoric (the Ottawa Charter being the most obvious example) as an important factor, healthy public policy has not been included as an element in any of the operationalized models.

There remains a gap in community health measurement between the rhetoric, determined largely by conceptual understandings of health, and the reality, driven by availability of data. There appear to be two ways of dealing with this problem. First is to find new ways of using existing data, combining data in different ways (as in measurement of inequalities in health). Second is to collect new data that cover areas not yet measured.

Measures of nutrition and capacity for coping -- two areas suggested in Chapter 1 as potential foci for positive health assessment -- are not represented in the current profile. While nutritional measures have been extensively researched and used in a variety of settings, indicators of coping are far less well defined and researched. Further work is needed to move the profile in the direction of positive health.

Community-level or, to use Morgenstern's nomenclature, environmental and global indicators are increasingly being used and researched in public health applications. Work in areas such as restaurant or grocery store indicators of dietary change,[41,42] and legislation and community mobilization around tobacco use[43] highlights the potential of these types of measures for rapid, unobtrusive investigation of community-level phenomena. Such measures could add a more community-level focus to the OCHP section on lifestyle and behavioural factors. In 1994 the Centres for Disease Control and Prevention brought together a group of evaluators for a think tank on community-level indicators.[44] A range of indicators for tobacco use, physical activity and diet & nutrition were given scores between 0 and 5 by the participants. The indicators fell into four main categories: policy and regulation, information, environmental change, and behavioural outcome measures. Some examples of indicators which received high rankings for quality and feasibility at that session are listed in table 3.2.

Table 3.2 Examples of categorized community-level indicators selected by a CDC think tank for three public health issues[44]

Theme	Category	Indicator
Tobacco Use	Policy and Regulation	clean air laws for public buildings, restaurants, worksites etc
		prohibition on use of tobacco products on public property
		excise tax on tobacco products
	Information	materials for screening and cessation in use by health professionals
		signs telling of environmental tobacco smoke
	Environmental Change	% of restaurant seats in no-smoking sections
		price of tobacco products
		existence of smoking control programmes in public health agencies
	Behavioural Outcome Measures	surveillance data on tobacco sales to minors
		disappearance of tobacco products (store inventory)
Physical Activity	Policy and Regulation	highway funds for non-vehicle transport
		presence of local policy to include PE in public k-12 curriculum
		walk/bike paths included in local zoning/rezoning requirements
	Information	% of health care providers that routinely advise patients to exercise more
		availability of materials in worksites linking PA to CVD
	Environmental Change	miles of walking trails / bike lanes per capita
		number of physical activity per capita in schools
	Behavioural Outcome Measures	observations of usage (in malls, trails)
		membership in physical activity organizations (Y's, health clubs)
		% time in PE classes spent in "lifetime" exercises
Diet & Nutrition	Policy and Regulation	% schools with lunch options congruent with dietary guidelines
		publicly funded food programmes follow dietary guidelines
		index of local policies regarding: nutrition at school, day care, after school and weekend events
	Information	number of media reports dealing with issue
		"point of purchase" education materials
	Environmental Change	presence of healthy foods in school or worksite vending machines
	Behavioural Outcome Measures	bar code sales data
		proportion of low-fat items in schools
		inventory control data (worksite & school cafeterias) for food usage

Indicators of 'social capital' outlined in the Agroecosystem Health Project[45] that focus on degrees of social organization and mobilization (community groups, businesses, religious congregations etc) may also be applicable in the OCHP category for social indicators. Food basket analyses — estimating cost and nutritional availability at a local level — are used by health departments and community health centres in certain areas.[46] These types of indicators could be incorporated into the OCHP section on economic indicators. The inclusion of environmental variables in the section on physical environment gives the OCHP more community-level coverage than most. Including some of these other measures in the remaining categories would greatly enhance the community-level coverage of the profile.

This ranking exercise is admittedly subjective, as the interpretation of each indicator may vary, depending on who is doing the assessment. However, it does serve to illustrate the divergence between a theoretical orientation toward more positive understandings of health and the realities of defining measurable indicators for which data are available. At present, further empirical testing of the maps is limited by the unavailability of data on positive heath and community-level indicators. Once more positive, community-level health data are defined and collected within health units, empirical analysis could begin with a testing of the relationship between indicators in each of the quadrants of the framework. A major contribution -- possibly feasible with existing data -- would be to define measures of inequalities in health for Ontario health units, and to test their relationship with the rates, proportions and means currently used.

The exercise in this chapter has also illustrated how the framework may be used to demonstrate the relevance of indicator profiles in general, and the relevance of the OCHP in particular. It remains to test its usefulness for community health workers and researchers in assessing the face validity of indicators and profiles.

Chapter 4

Representativeness of the Ontario Community Health Profile

In addition to conceptually reflecting a definition of community health, the OCHP must also represent the individuals and communities it is intended to cover. There are two main issues that affect the representativeness of the profile: the coverage of the data sets used, and the characteristics of the indicators themselves.

If the data set itself excludes members of the population -- especially homeless and other marginalized groups that are not included in household surveys or telephone interviews -- the indicator will not reflect the reality of the whole population. This is the case with surveys such as the OHS, where sub-populations such as prisoners and homeless were under reported or not studied at all. This type of coverage is documented in survey and census information, under the category 'non-sampling error.'[47] Indicator guides, such as the Ontario Community Health Profile[3] and the Canadian Institute for Health Informatics 'Definitions and Interpretations' publication[48] include information on non-coverage and response rates in the 'Limitations' section for each indicator.

While data set coverage is commonly assessed, less attention has been paid to the way in which the choice of indicators can affect the profile's representativeness. For example, in measuring mortality, the completeness of the mortality registry is just one important consideration. Equally important is the degree to which the indicator of mortality reflects the community's diversity. A simple mortality rate may not be sufficient to capture the diversity within the community. Reporting only mean values or overall rates for large areas may obscure important variations within those areas. When dealing with higher levels of aggregation, it is helpful to take into account the dispersion of the data, and not merely report the measure of central tendency (mean or rate). Thus, it may also be necessary to measure the distribution, or inequalities in mortality. According to much of the recent literature on inequalities in health, health outcomes are very strongly linked with distribution, not simply mean values of socioeconomic status. Wilkinson suggests that equality reflects social cohesion, which he argues is a major determinant of health in populations, explaining much of the variance in life expectancies between developed nations.[49] If this is the case, measures of dispersion may provide important information about the health 'of' the community.

In recent years, there has been increasing interest in measuring the distribution of health within populations. Papers by Wagstaffe *et al.*[50] and Makenbach & Kunst[51] review available measures of inequalities in health. Measures such as the range, rate ratios or rate differences between highest and lowest groups only take into account the extremes of the population, saying nothing about the experience of the majority of the population between these poles. Instead, these authors favour measures based on the relationship between selected health outcomes and population groupings such as socioeconomic categories -- the main topic of interest for research in health inequalities. These measures include the slope index of inequality and the relative index of inequality. Other measures, such as the index of dissimilarity and the Gini coefficient provide a non-directional measure of distribution as they are either univariate or bivariate with nominal categories.

This thesis does not develop measures of equality appropriate to the OCHP. Rather, it examines the need for additional measures by testing the degree to which the rates and means currently used reflect the diversity within the communities they represent.

The PHU represents a large population, often spread over a significant geographic area, which does not comprise a single 'community' as such. Rather, it is composed of a collection of smaller geographic communities. Thus, there is a trade-off of aggregation. While larger aggregations will yield more stable estimates they also tend to produce indicators which reflect less of the actual experience in the community. For example, an indicator reported for each census sub-division (CSD) will represent the experience of each community more accurately than an indicator reported for the PHU as a whole.

One of the main questions here is whether taking into account small area variation within the PHU affects the assessment of the PHU overall and comparisons among PHUs. To answer this question, we need to know the extent to which values of a given indicator for small areas within the PHU deviate from the value of the indicator for the health unit as a whole.

Research Question #2: **How well do OCHP indicators reflect the diversity of the census sub-divisions within each public health unit?**

This analysis uses two methods of testing the null hypothesis of no variation between CSDs within each PHU: parametric testing using standardized incidence ratio confidence intervals, and non-parametric testing using the chi-square statistic.

Parametric Testing of the Null Hypothesis of No Variation Between CSDs Using SIR Confidence Intervals

Methods

Two parametric methods have been used by other investigators to answer similar questions in small-area analyses -- ANOVA and standardized incidence ratio (SIR) confidence intervals. The discussion below argues that calculating SIR confidence intervals is the more appropriate of the two for this analysis.

In their work on the significance of variations in small area health service admissions, Cain and Diehr suggest an approach using ANOVA to evaluate the relationship between variation among small areas (in this case CSDs) and variation between larger counties (in this case PHUs).[52] The F-value compares variation within PHUs and variation among PHUs, calculated as . $F = \frac{MSC}{MSE}$ where MSC is the mean square due to counties (or PHUs in this case) and MSE is the mean square due to error, also defined as variation within counties (or PHUs). A significant F-value would indicate that there is significant variation between PHUs, taking into account the variation within PHUs (between CSDs). This would suggest that a PHU-level rate or mean may be a fair representation of the communities within that health unit. However, the implications of a non-significant F-value are less clear. One interpretation of a non-significant F-value is that the variation within health units (MSE) is sufficiently great that no significant difference between health units can be detected. In other words, the variation among CSDs is sufficiently great that indicators aggregated to the PHU level have little relevance to the communities within those health units. However, a second interpretation is that the variation between health units (MSC) is small and thus, even if there was little variation within PHUs, the F-value would still be non-significant. As we are interested only in the relationship between the value of the PHU-level indicator and the values for CSDs within each PHU *on a health unit by health unit basis*, this test is not as useful as the SIR test described below. Also, Levene's tests[76] reveal the data to be quite heteroscedastic for many of the indicators, violating one of the basic assumptions for an ANOVA test. Instead, an approach based on standardized incidence ratios addresses the question of representativeness more directly.

The standardized incidence ratio (SIR)has been used to study the extent to which small areas of analysis differ from provincial or regional averages. Examples include the comparison of municipal colon cancer rates to the *département* average in France[53] and comparison of health regions to the provincial average in Manitoba.[54] The SIR is a method of indirect standardization which allows comparison between the observed number of cases (O) in a population and the number that would be expected (E), based on a standard rate. The basic formula is as follows:

$$SIR = \frac{O}{E} \times 100\%$$

The ratio is generally expressed as a percentage. Populations with an SIR less than 100 have rates lower than expected. Populations with an SIR greater than 100 have rates higher than expected. The Manitoba PHIS used SIR calculations for many of its indicators. Thus, values for health regions within the province were expressed relative to the overall provincial rates. The method identifies areas which are particularly high or low and thus has utility for targeting programmes.

The SIR is age-standardized in that it uses age-specific rates to calculate the expected number of cases. Standard, age-specific rates (based on national, provincial, or other reference-area rates) are calculated. The number of expected cases is based on the number of person-years in each age category in the population of interest, multiplied by the standard rates in each age category. Thus, it is only necessary to know the standard rates, the overall number of observed cases, and the number of person-years in each age category in order to calculate a SIR for a given population. For this reason, the SIR is preferable to calculating directly age standardized rates for small areas, since the age-specific rate estimates within the small areas will often be based on too few cases or none at all.

Using the PHU rate as the standard rate, an SIR was calculated for each CSD within it. Thus, each CSD rate is expressed relative to the PHU rate. The extent to which CSD rates significantly deviate from the PHU rate reflects how well the PHU value represents the diversity of its population. If there are a high number of CSDs which deviate significantly from the PHU value, the PHU level indicator may be masking a good deal of variability among communities within the region.

One way of determining which CSDs significantly differ from the PHU rate is to calculate confidence intervals for the SIR. Confidence intervals which do not encompass 100% indicate CSD rates which are significantly different from the PHU rate. The confidence interval calculations used here are based on Estève *et al.* who examined regional variation in cancer rates in France.[53] Confidence intervals are calculated based on the observed number of cases, represented by 'O' (consider these observations time-bound samples of a 'true' underlying rate in each region). For values of 'O' below 50, the confidence limits can be defined according to a Poisson distribution. Defining the lower and upper bounds of the confidence interval for a Poisson variable as μ_0 and μ_1 respectively, the 1-α confidence limits are calculated according to the following formulae:

$$P[X \geq O \mid \mu_0] = \alpha/2 \; ; \; P[X \leq O \mid \mu_1] = \alpha/2$$

Estève *et al* provide tabulated values for μ_0 and μ_1 based on these functions for values of O up to 50. These values can be divided by the expected number of cases (E) to provide upper and lower SIR limits. For values above 50, confidence intervals can be calculated by approximating the distribution of $\sqrt{X}$ using a normal distribution with mean $\sqrt{\mu}$ and variance 1/4. The formula for this calculation is given below:

$$[\mu_0;\mu_1]=[(\frac{Z_{\alpha/2}}{2}-\sqrt{O})^2;(\frac{Z_{\alpha/2}}{2}+\sqrt{O+1})^2]$$

This analysis uses the tabulated Poisson values when there are less than 50 observed cases and the normal approximation when there are more than 50 observed cases. The following example may help to illustrate the calculation of SIRs and confidence intervals:

In the Ottawa CSD, 7698 cases of cancer were reported while, based on the rates for Ottawa-Carleton PHU, only 4553 were expected. Dividing the observed number of cases by the number expected yields 1.6909, or an SIR equal to 169.09. Using the normal approximation formula above, the confidence limits around the observed number of cases are 7527 and 7872 respectively. Dividing these numbers by the expected number of cases and multiplying by 100, we get estimates of the lower and upper bounds of the 95% confidence intervals for SIR: 165.34 and 172.91 respectively.

The analysis of representativeness was carried out on all variables for which CSD-level data were available. This eliminated OHS-based indicators and indicators such as life expectancy which could not be calculated reliably for CSDs due to insufficient caseloads. However, some inferences can be made. For instance, since life expectancy is essentially based on age-specific mortality rates, the results of the SIR analysis of mortality rates (for which there was sufficient information at the CSD level) should also reflect variation in life expectancy. Only PHUs in the Eastern Ontario planning region were included in the analysis. Data from the Health Information Partnership of Eastern Ontario only cover this region. The six PHUs in Eastern Ontario are: Eastern; Hastings & Prince Edward (HPE); Kingston, Frontenac, Lennox & Addington (KFLA); Leeds, Grenville, Lanark (LGL); Ottawa-Carleton (OC); and Renfrew.

For each eligible indicator, age-specific rates were calculated at the PHU level. Based on these age-specific rates, the expected number of cases in each CSD were calculated by multiplying the age-specific rates by the number of person-years in each age group. The expected numbers of cases were then summed across age groups. The observed number of cases in the CSD was divided by the total expected number of cases and then multiplied by 100 to yield a percent SIR value for each indicator in each CSD. 95% confidence intervals were then calculated as described above. The percentage of SIRs which were found to be significantly greater than or less than 100% (the PHU value) was reported for each indicator in each PHU.

One major shortcoming should be noted here. Due to coding inaccuracies in mortality data, the mortality data could not be matched correctly with the corresponding census data for several CSDs in the Eastern and Leeds, Grenville, Lanark health units. In Eastern PHU, only 15 of 40 CSDs were correctly coded, and only 21 of the 42 CSDs in Leeds, Grenville, Lanark were correctly coded. Thus, these CSDs have been omitted from the analysis of the mortality based indicators (standardized mortality rate and potential years of life lost).

Results

The results, by indicator and PHU, appear in Table 4.1. There appears to be a great deal of variation among PHUs in terms of the number of CSDs yielding significant SIRs.

Table 4.1 Percentage of CSDs in each PHU with standardized incidence ratios (SIR) significantly deviating from 100%, by indicator

Indicator	Percent of CSDs with significant SIR					
	Eastern	HPE	KFLA	LGL	OC	Renfrew
	N=40	N=39	N=29	N=42	N=11	N=38
low birthweight	10	0	3.7	2.6	27.3	11.4
mortality rate	-	74.4	51.7	-	90.9	56.8
infant mortality rate	0	0	13.3	4.2	18.2	6.7
perinatal mortality rate	3.2	0	10.5	8	9.1	0
potential years of life lost	-	92.1	65.5	-	100	89.2
cancer incidence	69.2	48.7	79.3	69	90.9	55.3

Note: Cells for mortality rate and PYLL in Eastern and LGL health units have been omitted due to high numbers of missing CSDs

Appendix 2 presents the graphs of SIRs with confidence intervals for each indicator in each health unit. The CSDs are listed in order of increasing population (or live births in the case of LBW, IMR and PMR). The Y-axis is on a logarithmic scale except for IMR and PMR which had some CSD values equal to zero, and are thus represented on a linear scale. SIR=100% is represented by the horizontal reference line. As illustrated in these graphs, the confidence intervals for infant mortality rate, perinatal mortality rate and low birth weight are very large. This is due to small numbers of observations even over a five year period at the CSD level. Thus, the results for these indicators do not reflect even large amounts of variation between CSDs in each PHU. Potential years of life lost, cancer incidence and mortality rate appear to vary a great deal among CSDs. Again, while this analysis demonstrates statistical significance, the size of the confidence intervals is an issue. If the intervals are small due to large numbers of observed cases, even small variations in SIR values may be classified as statistically significant. Thus, we must address the issue of the practical (analogous to clinical) significance of these statistically significant findings.

The graphs in Appendix 2 provide a picture of the actual variation between CSDs in each PHU. To further assist in assessing the practical significance of deviation from PHU values for mortality, PYLL, and cancer incidence, Table 4.2 lists the percentage of CSDs within each PHU that deviate by more than a factor of 1.5 (SIR is less than 66.67 or greater than 150). From this table, we can see that many of the CSDs which had statistically significant SIRs are not considered practically significant at this level. Nevertheless, despite the broad range of variation covered by a factor of 1.5, between 33 and 60 per cent of CSDs in Eastern Ontario PHUs had SIRs outside this range, suggesting that the variation is practically as well as statistically significant.

Table 4.2 ***Percentage of CSD rates within each PHU that deviate from the PHU rate by more than a factor of 1.5 (SIR is less than 66.67 or greater than 150)****

Indicator	Percent of CSDs with SIR<66.67 or SIR>150.00					
	Eastern	HPE	KFLA	LGL	OC	Renfrew
	N=40	N=39	N=29	N=42	N=11	N=38
mortality rate	-	51	45	-	36	51
potential years of life lost	-	62	38	-	45	57
cancer incidence	49	50	59	60	33	52

*birth measures (IMR, PMR, LBW) are excluded here due to insufficient caseloads

Non-Parametric Testing of the Null Hypothesis of No Variation Between CSDs Using Chi-Square Test

Methods

Non-parametric methods have also been used to test the degree of variation between small areas. In a simulation exercise, validating measures of small area variation in hospital admissions, Diehr *et al.*[55] reviewed the extremal quotient, coefficient of variation, systematic coefficient of variation and the chi-square statistic. They found the chi-square to be the most robust of the measures in detecting significant variation among small populations within a given county. Each small population was split into two groups based on whether or not individuals had experienced a particular event. These two categories were then cross-tabulated with the geographic code for each population. Hence, they created a 2Xk table, with k equal to the number of communities in a particular county. From this table, a chi-square statistic, with k-1 degrees of freedom was calculated. The results indicated that the chi-square analysis was robust despite variation in population sizes and low incidence rates, provided that the number of readmissions were low and that the cell expected frequencies were greater than 5.

In the same way, the chi-square test may be used to assess the degree of variation between CSDs for a given health status indicator within each health unit. A high degree of variation between CSDs will suggest that aggregating the indicator to the level of the health unit may be masking significant diversity within the health unit.

For each health unit, the population of each CSD was divided into affected and non-affected individuals, cross-tabulated with outcome. A Pearson chi-square statistic was calculated to test whether the variation among CSDs within each PHU was statistically significant. The chi-square has been criticized in geographic variation studies for being too sensitive, especially when multiple comparisons (as opposed to area-by-area comparisons) are being made.[56] Thus, α=.01 was used as a more appropriate level of significance for this test.

Results

Results of the analysis are shown in Table 4.3. Shaded cells in the table represent health units within which the chi-square statistic for the given indicator was statistically significant. It should be noted that low birth weight, infant mortality, and perinatal mortality all had low expected cell frequencies, with a high number of expected frequencies less than five. Thus, the results of these tests should be interpreted with caution.

Mortality rate and cancer incidence both yielded high expected cell frequencies. Cancer incidence is expected to have few multiple occurrences in the 5-year period of the study (i.e. double coding of individuals) and mortality rate is certain to have a low multiple occurrence rate. Thus, the test statistics for these outcomes can be interpreted with more certainty. However, as described in the preceding section, coding problems for CSD mortality data in the Eastern and Leeds, Grenville, Lanark health units resulted in a high number of missing CSDs. Thus, these two health units have been omitted from the table.

Mortality and cancer incidence indicators yielded chi-square values which were highly significant ($p<.001$) in all health units. As with the SIR analysis, when interpreted with the help of the graphs in Appendix 2, the results indicate that there is a considerable amount of variation between CSDs in each health unit.

Table 4.3 *Results of chi-square tests for significant variance of selected health status indicators between CSDs within each PHU in Eastern Ontario*

Indicator	Eastern			HPE			KFLA			LGL			OC			Renfrew		
	X^2	df	sig	X^2	df	sig	X^2	df	sig	X^2	df	sig	X^2	df	sig	X^2	df	sig
low birth weight	56.392**	39	0.035	36.619**	39	0.579	36.283**	28	0.136	57.417**	41	0.046	48.454*	10	<0.001	45.639*	37	0.156
mortality rate	-	-	-	2513.69	38	<0.001	3069.07	28	<0.001	-	-	-	4030.23	10	<0.001	1621.02	36	<0.001
infant mortality rate	26.261§	37	0.848	33.317§	36	0.597	47.641§	27	0.008	57.761§	40	0.034	19.951*	10	0.03	55.718§	36	0.019
perinatal mortality rate	55.427§	37	0.026	38.075§	37	0.42	65.380§	27	<0.001	60.565§	40	0.019	18.325*	10	..050	44.740§	36	0.151
cancer incidence	702.775	38	<0.001	812.682	38	<0.001	868.848	28	<0.001	1174.16	41	<0.001	1544.01	10	<0.001	710.257	37	<0.001

Shaded cells represent significant chi-square value (p<.01)

Note: results for mortality rate in Eastern and LGL health units have been omitted due to missing CSDs.

* 5-10% of cells have expected value < 5
** 15-35% of cells have expected value < 5
§ 40-50% of cells have expected value < 5

Discussion

Within the limitations of the analyses, both non-parametric and parametric tests suggest that there is significant variation in mortality and cancer incidence between CSDs within the health units of Eastern Ontario. It is difficult to draw any conclusions from the results for low birth weight, infant mortality and perinatal mortality. Larger caseloads, perhaps drawn from a longer time period are needed in order to more rigorously assess the variability of these measures within health units. Without adequate data on a wider range of indicators at the CSD-level, inferences must be made based only on the results for the mortality and cancer measures.

The generalizability of the results is also limited by the focus here on Eastern Ontario, for which HELPS data from the Eastern Ontario HIP were available. However, the health units of Eastern Ontario are not markedly different from the rest of the province. Given the extent of the diversity within these health units, one would not expect very different results for the rest of the province.

The high degree of variation between CSDs for mortality and cancer incidence suggests that simply reporting the rates at the PHU level is not sufficient. The variation is too great within the PHU for a single rate, proportion or mean to adequately represent that diversity. The argument may be made that reporting rates, proportions or means at the PHU level is technically correct and sufficient, as those values do actually represent the number of cases or the mean value of the measure one would expect to find in that PHU as a whole. However, this view reflects a purely utilitarian perspective as described in Chapter 1. If the profile is to reflect a concern for distributive justice, which is an emerging focus in areas of public health, it must include measures that reflect the distribution as well as the overall 'amount' of health or ill-health in the health unit.

This is a case for the use of measures of dispersion, or inequalities in health as described earlier in this chapter. However, the unavailability of adequate data to calculate these measures for a number of indicators may be a major limitation. Chapter 5 discusses in more detail the availability of data at various levels of aggregation. Indicators based on the OHS, or available only for selected areas within health units may not provide enough information for analysis at the sub-PHU level. The analysis in this chapter was limited to six of the 21 health status indicators because of lack of data. Of those six indicators, only three provided sufficient cases over a five-year period to be analysed at the CSD-level. There are a few possible responses to this problem. One possibility is to increase the time period over which data are analysed. This decreases sensitivity to change over shorter time periods, but may help produce sufficient cases of rarer occurrences such as the birth measures used here. This approach will not increase the number of indicators for which sub-PHU-level data are available. A second approach is to identify possible proxy indicators that are available at the sub-PHU-level and are related to indicators that cannot be disaggregated beyond the PHU. Proxy indicators are discussed further in Chapter 5. A third option is the use of sentinel surveillance, which is also discussed more thoroughly in Chapter 5 in the section on availability of the indicators.

This chapter has identified a need for measures that better reflect the diversity within health units than the currently used rates, proportions and means. This conclusion is somewhat limited in its generalizability due to the analysis' focus on a select number of available indicators in the Eastern health region of Ontario. Nevertheless, the degree of diversity measured for these indicators within these health units suggests that the problem may be more widespread. While measures of inequalities in health developed elsewhere may be applicable here, the availability of adequate data to produce these measures may limit their utility. Attention to diversity within health units is necessary if community health measurement is to reflect a distributive justice perspective, which is discussed in Chapter 1 as an emerging focus in public health.

Chapter 5

Practicality of the Ontario Community Health Profile

If the Ontario Community Health Profile is to be a useful tool for community health measurement, it must be practical. This chapter examines the indicators in the profile according to five practical criteria: their availability, stability, timeliness, format and parsimony.

1. Availability

Indicators based on data that are easily available to health units will obviously be preferred to those that require further data collection. However, data that are readily available from central sources, such as the HELPS data set used in these analyses, may not always provide data at a low enough level of aggregation to be truly useful for a health unit. Here, indicators in the OCHP are assessed based on the lowest level of aggregation of the available data for each indicator..

Data at lower levels of aggregation are generally preferred as it is always possible to aggregate from lower to higher levels but not to disaggregate when data are given at higher levels to begin with. Many health units take data at the level of municipalities or census subdivisions (CSDs) and aggregate them to form sub-PHU planning regions. Lower levels of aggregation also allow for more accurate data linkage, reducing biases due to the ecological fallacy.

The level at which data are made available may be affected by confidentiality issues (for example, census data may be rounded to the nearest multiple of five, or not reported below certain levels of aggregation), practical considerations (record-level data sets being much larger than summary data sets), and the unit of observation (were data collected at the individual level, at an institutional level, or as environmental data, etc.).

Research Question #3: At what level of aggregation are OCHP indicators available?

The level of disaggregation at which each indicator is available is largely determined by the data source. Table 5.1 presents the number of indicators available at each level of aggregation for each of the OCHP categories. It should be noted that the Livebirth, Mortality and Cancer databases contain individual level data. The level of aggregation refers to the lowest level at which the data are coded for deriving rates. Census data were used to calculate the denominator for each of these indicators. Missing data and changes to the coding of CSDs in recent years result in some unmatched cases at the CSD level, reducing the availability of indicators for certain areas. The Ontario Health Survey was designed to provide good estimates at the PHU level. Due to sample size and the cluster sample design, data can not be disaggregated any further than the PHU.

Table 5.1 Number of indicators available at each level of aggregation for the OCHP categories

category	number of indicators			
	total	CSD-level	PHU-level	Province or selected communities only
demographic	11	9	2	-
economic	10	8	1	1
social	8	2	5	1
physical environment	5	2	1	2
health-related practices	11	-	11	-
health status	21	12	8	1
total	**66**	**33**	**28**	**5**

The OCHP lists 11 **demographic** indicators, of which eight are based on the census (seven available for CSDs and one at the PHU level only). Two are from the Livebirth Database, also at the CSD level, and the remaining indicator, therapeutic abortion ratio, is taken from the Institutional Services Branch of the Ontario Ministry of Health available for counties (in most cases a smaller area than the health unit).

Of 10 **economic** indicators, six come from census data and are available at the CSD level. Percentage of the population on social assistance is available from the Ministry of Community and Social Services at the sub-PHU level. Data on subsidized rental accommodation are derived from the OHS, available at the PHU level. Percent receiving food from food banks is generally available from municipal food banks.[77] The unemployment rate is based on the Canadian Labour Force Survey estimates and census information available for CSDs.

Four of the eight **social** indicators in the OCHP are derived from the OHS and are thus available only at the PHU level. Average persons per room comes from the census and is available at the CSD level. Data on violent crime are available at the municipal level as reported by local police departments. Voter participation is available for electoral districts which do not correspond directly with PHU boundaries. Literacy rates are available only at the provincial level as they are derived from a national survey undertaken in 1989.

The OCHP lists five **physical environment** indicators which vary in their availability. Two of the indicators, Air Quality Index (AQI) and frequency of poor water quality, are available only from selected sites throughout the province. Thus, information is only available for specific PHUs, and only for specific areas within those PHUs. Data for closing of public beaches are available at the PHU level, as it is the Medical Officer of Health's responsibility to monitor beach safety. Water quality and public green space data are both available at the municipal level.

All of the 11 **health related practices** indicators in the OCHP are derived from the OHS. Thus, data on these behavioural indicators are not available for areas smaller than the PHU. This limits the health unit's ability to identify high risk communities, or to obtain measures that are sensitive to variation between communities within the PHU (this is discussed further in the section on population coverage).

Of the 21 indicators listed under '**Health Status**' in the OCHP, 12 are available at the CSD level and eight are available only at the PHU or DHC level. Data on the incidence of occupational injuries are only available at the provincial level and are thus unsuitable for use by Ontario PHUs. Table 5.2 lists the OCHP Health Status indicators according to the data set from which they are derived, indicating the lowest level at which each indicator is available.

Table 5.2 *Health Status indicators by data set and available level of disaggregation*

Dataset	Lowest Level of Aggregation	Indicators
Ontario Mortality Database	CSD	* life expectancy * leading causes of death * mva mortality * suicide rate * potential years of life lost
Ontario Livebirth Database	CSD	* low birthweight * infant mortality rate * perinatal mortality rate
Ontario Cancer Incidence	CSD	* cancer incidence
Canadian Institute for Health Information (CIHI)	CSD/Institution	* hospital separations * hospital morbidity due to injury * hospital days of stay
Ontario Health Survey	PHU	* self-perceived health * chronic health problems * contemplated suicide * prevalence of long-term disability
Public Health Branch	PHU/DHC	* major notifiable diseases * notifiable diseases requiring vaccination * immunization status * dental index
Worker's Compensation Board	Province	* incidence of occupational injuries

Discussion

The analysis of data availability by data source points to the OCHP's clear reliance on the OHS (20 of the 66 indicators). As discussed in the analysis of timeliness, the OHS data, collected in 1990, are becoming increasingly dated. Nevertheless, health units are still having to rely on OHS data to produce a community health profile. As one example, a fairly recent Community Health Status Report from one of the Eastern Ontario health units was almost entirely reliant on OHS data (Renfrew County and District Health Unit 1996). At present, Ontario PHUs lack a routinely collected data set on perceptions of health, disability & functional limitations, and a wide range of lifestyle and behavioural issues. They also do not have access to reliable longitudinal data on those variables in their regions.

2. Stability

As stated in the previous section, indicators based on data that are easily available at lower levels of aggregation are preferred to those for which data are highly aggregated. However, indicators that are based on data at low levels of aggregation may yield estimates that are unstable due to insufficient sample sizes. For example, although mortality data might be available at an individual level (as individual death records), there is a level of aggregation below which mortality rates cease to be a useful indicator of community health. This threshold level will differ between indicators and will be affected by the frequency of the phenomenon being measured, the size of the population, the homogeneity of the population, the method of calculation (indicators such as life expectancies and standardized rates depend on category-specific rates which are at levels of aggregation below that of the final reported value), and the method of data collection (for example, complex sample data have greater variance, and therefore provide less stable values). The level of aggregation at which meaningful indicator values are available reflects true availability better than simply the lowest level of data aggregation.

Research Question #4: **At what level of aggregation do OCHP indicators provide stable estimates?**

Methods

We need an indication of the stability of the indicators. Indicators that tend toward instability at the PHU level can be identified using the coefficient of variation. Coefficients of variation (CV) are commonly used (for example by Statistics Canada) to estimate the confidence with which a particular value can be reported. Comparisons of standard deviations are affected by different units of measurement, and by the size of the mean or rate itself. The CV avoids these problems by expressing the standard deviation as a fraction of the mean or rate. The basic formula for the CV of an estimate is its standard deviation divided by the mean:

$$CV=\frac{\sigma}{\mu}$$

Standard deviation could be calculated for potential years of life lost as this is a continuous measure at the individual (sampling unit) level. Variance estimates for life expectancy in Ontario for 1990 have been taken from Manuel.[70] However, most of the health status measures reviewed here are either measures of prevalence (proportion in fair or poor health, proportion with one or more chronic health problems, proportion having contemplated suicide and prevalence of long term disability) or incidence (low birth weight, mortality rates, hospital separations and hospital days of stay). The following formulae illustrate an analogy to the CV for continuous measures, using the standard deviation for an observed number of events. Following this, a CV calculation based on the standard error of a proportion as used by Ferland *et al.*[57] is shown to be an equivalent approach.

For a proportion (p), standard deviation is calculated based on the number of observed cases 'O.' Variance (O) equals $np(1-p)$, where n is the sample size; and standard deviation (O) equals $\sqrt{np(1-p)}$.[58] Where p is calculated using O/n, the equation for standard deviation becomes:

$$S.D.(O) = \sqrt{O(1-\frac{O}{n})}$$

The standard deviation is then divided by the observed number of cases (*O*) in order to calculate the relative size of the variance (the CV). Simplified, the equation for CV becomes:

$$C.V.(O) = \sqrt{\frac{1-\frac{O}{n}}{O}} \times 100\%$$

Where the proportion *p* is very small, 1-*p* approaches 1 and the equation reduces to:

$$C.V.(O) \approx \sqrt{\frac{1}{O}} \times 100\%$$

CV may also be calculated using the standard error of the estimate, based on a binomial probability distribution and calculated by the formula:

$$S.E.(p) = \sqrt{\frac{pq}{n}}$$

where $q=1-p$.[58] The CV for proportions is calculated by dividing the standard deviation by the proportion and expressing the outcome as a percentage, yielding the formula:

$$C.V. = \frac{\sqrt{\frac{pq}{n}}}{p} \times 100\%$$

Using *O/n* to calculate *p*, this equation simplifies to:

$$C.V.(O) = \sqrt{\frac{1-\frac{O}{n}}{O}} \times 100\%$$

which is equivalent to the equation derived above based on the variance of '*O.*'

The standard error for a rate is based on a Poisson probability distribution, with the formula:

$$S.E.(R)=\sqrt{\frac{R}{PY}}$$

where R is the rate (number of events occurring over a given time at risk) and PY is the time at risk in person-years.[59] As with the CV for a proportion, the CV for a rate is the standard error divided by the estimate (R).

While the calculation of CVs for rates and proportions differs in theory, the formulae are basically the same given the low prevalence of most outcomes. As p becomes very small, q (defined as 1-p) approaches 1 and the equation for standard error becomes:

$$S.E.(p)\approx\sqrt{\frac{p}{PY}}$$

which is analogous to the calculation for standard error of a rate.[58]

Simplified, the equation for CV based on the standard error of a rate is:

$$C.V.(O) = \frac{\sqrt{\frac{R}{PY}}}{R} = \sqrt{\frac{1}{R \times PY}} = \sqrt{\frac{1}{O}} \times 100\%$$

which is equivalent to the equation derived above, based on a small number of observed cases (*'O'*).

Expressing the standard deviation as a percentage allows us to compare the variances of different variables, and to decide on benchmarks for acceptable levels of variability. Statistics Canada and the Ontario Health Survey provide guidelines for the release of data based on CV. Since many of the indicators are based on OHS data, this analysis uses the guidelines outlined for the OHS.[47] The guidelines are as follows:

CV ≤ 16.5%:	accurate enough to be released unconditionally
16.6% ≤ CV ≤ 25.0%:	high sampling variability, should be used with caution
CV > 25.0%:	not considered reliable enough to be released

Statistics Canada guidelines are basically the same except the upper bound for the middle category is 33.3% rather than 25%. As the main focus of this analysis is to determine which indicators provide 'accurate' estimation (a CV of 16.5% or below), this difference should have little bearing on the results.

While the calculation of CVs for survey data is quite common, some may question the necessity of providing CVs for indicators based on census data, as census data are not statistical estimates but rather are based on the entirety of the population. However, if we assume that there is some underlying 'true' rate within a population, a census is actually a time-limited sample. Such cross-sectional data are just a snapshot of an ongoing reality within a population. The CV indicates whether there is a sufficient sample size based on time period (accumulating sufficient person-years to make the estimate stable), not just the number of individuals. The CV has been used in this way to assess the confidence with which OHS data could be reported[47] and to determine whether rates were sufficiently stable to be included in a Québec health profile.[57]

As already discussed, estimates based on the OHS are weighted due to its cluster sample design. Since clusters tend to have internal similarity, standard deviations generated from cluster surveys tend to underestimate the actual variance. This is the design effect. A design effect coefficient, based on the relative size of the clusters and the intraclass (within cluster) correlation is generally used to correct for the cluster effect on variance estimates. Simply put, the design effect is equal to the variance estimated using cluster sampling (Var[C]) divided by the variance that would be calculated for a simple random sample of the same size (Var[R]). The design effect can be calculated using:

$$deff=\frac{Var[C]}{Var[R]}=[1+(N+1)\rho]$$

where N is the cluster size and ρ is the intraclass correlation.[60] Using design effect coefficients for health units provided by the OHS[61] modified standard deviations were calculated for use in the CV equation.

In order to estimate the number of PHUs yielding stable estimates for each indicator, CVs were calculated for each indicator in each of the 42 health units. The percentage of health units which fall within each CV category indicates the extent to which the indicators are providing stable estimates.

Results

The OCHP indicators which could be evaluated using the available data appear to yield fairly stable single year estimates at the PHU level. Appendix 3 presents graphs of the values for each health status indicator across all 42 health units, and the corresponding CVs. Health units are listed in order of increasing population. The horizontal reference line represents the CV 'stable' cut-off point of 16.5%. In general, as expected, the CV line graph drops as population increases. The graphs also illustrate clearly the interaction between population and number of cases in determining the CV.

The percentage of PHUs falling within each CV category is reported by indicator in Table 5.3. It is important to note that, for many of the indicators, there are several possible sub-categories such as gender, age, or cause-specific rates which may yield much less stable estimates. Table 5.4 presents crude mortality rate by cause, and shows that several of these sub-category indicators are less stable, due to much lower incidence rates. The main category 'crude mortality rate' appears to give stable one-year estimates, as do a few of the main causes: all cancers, lung cancer, circulatory system disorders, myocardial infarctions, ischemic heart disease, stroke, respiratory illness, and possibly injuries and poisoning (less stable with 80% of PHUs yielding a CV of 16.5 or below).

Table 5.3 Percentage of Health Units by Coefficient of Variation Category for Each Health Status Indicator

Indicator	% of PHUs		
	CV ≤ 16.5%	16.6% ≤ CV ≤ 25.0%	CV > 25.0%
life expectancy (female)	100	-	-
life expectancy (male)	100	-	-
low birth weight	97.6	2.4	-
self-perceived health	100	-	-
chronic health probs	100	-	-
cmr: all causes	100	-	-
infant mortality rate	14.3	33.3	52.4
perinatal mortality rate	100	-	-
suicide rate	15	47.5	37.5
contemplated suicide	100	-	-
motor vehicle accident mortality	16.7	47.6	35.7
pyll	100	-	-
hospital separations: psychoses, pneumonia, complications of pregnancy, ihd, falls	100	-	-
hospital morbidity due to injury	100	-	-
prevalence of long-term disability	88.1	11.9	-

***Table 5.4** Percentage of Health Units by Coefficient of Variation Category for Each Crude Mortality Rate Indicator Subcategory*

Indicator	% of PHUs		
	CV ≤ 16.5%	16.6% ≤ CV ≤ 25.0%	CV > 25.0%
cmr: all causes	100	-	-
cmr: infectious disease	19	23.8	57.1
cmr: AIDS	4.8	9.5	71.4
cmr: cancer	100	-	-
cmr: lung cancer	90.5	9.5	-
cmr: fem breast cancer	40.5	45.2	14.3
cmr: lymphatic & hematopoetic cancer	42.9	35.7	21.4
cmr: diabetes	38.1	42.9	19.1
cmr: alcoholism	0	4.8	88.1
cmr: drug dependence	0	0	14.3
cmr: circulatory system disease	100	-	-
cmr: hypertension	2.4	22	75.6
cmr: MI	100	-	-
cmr: IHD	100	-	-
cmr: stroke	95.2	4.8	-
cmr: resp disease	97.6	2.4	-
cmr: pneumonia	59.5	31	9.5
cmr: copd	64.3	33.3	2.4
cmr: asthma	0	2.4	85.7
cmr: inj & poisoning	81	19	-
cmr: homicide	0	2.4	78.5

Suicide rate is included in the list of 21 OCHP health status indicators. However, suicide rates appear to give unstable estimates, with only 15% of PHUs yielding a CV of 16.5 or below. Motor vehicle accident mortality is also one of the 21 health status indicators. Like the suicide rate, it is an unstable one-year estimate with only 16.7% of PHUs falling within the most stable category. Prevalence of long term disability is more stable, but still uncertain with 88% of PHUs having a CV of 16.5 or below.

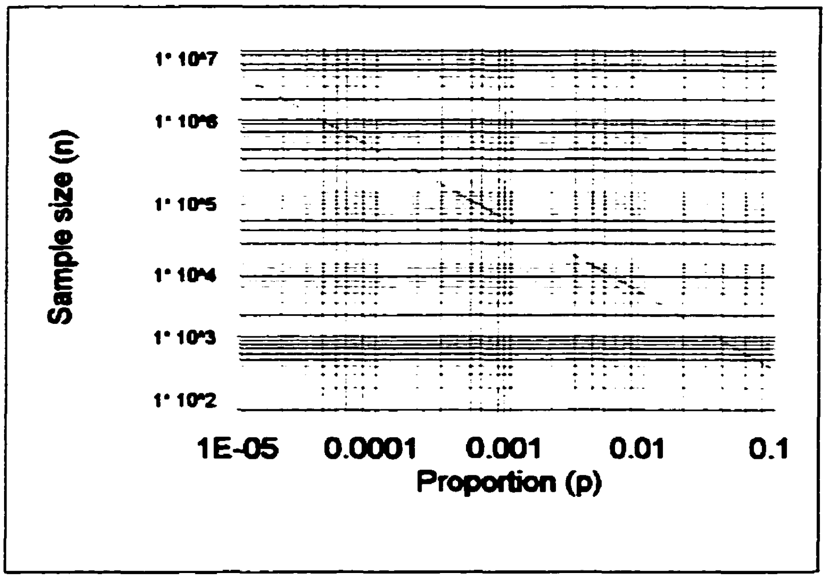
Discussion

With the exception of specific mortality rates such as infant mortality rate, suicide rate and motor vehicle accident mortality rate, this analysis suggests that the OCHP health status indicators are generally quite stable at the PHU level. Indeed, the method of calculating the coefficients of variation is conservative. The calculation of the CV in this analysis is based on a binomial distribution. A binomial model makes two main assumptions: that individual occurrences are statistically independent, and that each individual has the same probability of an occurrence. The second assumption is likely to be violated in calculating variances at the PHU level. As the analysis of diversity in Chapter 4 demonstrates, there may be a high level of heterogeneity within each health unit. Assuming homogeneous risk in a heterogeneous population will lead to overestimation of the actual variation.[58] Thus, this analysis will tend to be conservative at the PHU level. This increases the confidence with which the conclusion of stability can be drawn for most of the health status indicators. It also suggests that the instability of the specific mortality measures may be overestimated here. Conservative estimates of variance become a problem where one is trying to detect statistically significant patterns of a particular outcome. Thus, to reduce the risk of missing potentially important patterns of ill-health in the community, analyses should be done for sub-groups that are likely to be more homogeneous.

The CV, as calculated here, is essentially dependent on the rate or proportion and the population or sample size. Thus, the CV equation can easily be used to calculate the required population or sample size to provide stable estimates for a given rate or proportion. Figure 5.1 illustrates the inverse exponential relationship between proportion (p) and sample size (n)

required for a CV of 16.5.

Figure 5.1 ***Log-log graph of sample size required to achieve a CV of 16.5 for a given proportion (p)***



Given this relationship, unstable estimates could be improved by reporting five-year, rather than one-year estimates. The least stable of the health status indicators is infant mortality rate, with only 14% of health units within the cut-off of CV = 16.5 for single-year rates. When five-year rates are calculated, 81% of health units fall within the cut-off, with an additional 14% within the second category (CV between 16.5 and 25). However, five-year estimates are not available in the case of OHS-based indicators such as the prevalence of long-term disability. As already stated, the OHS was designed to give stable estimates at the PHU level, but estimates may be unstable for sub-populations defined by age, gender, geography etc. Five-year rates also reduce the sensitivity of the indicator to changes over time.

Another possible approach to the problem of highly variable estimates is that of sentinel community surveillance. Sentinel surveillance uses intensive data collection in selected 'sentinel' communities, as opposed to limited data collection spread over a large area. The method has been used in a variety of settings, including monitoring and predicting infectious disease outbreaks in US cities[62] and monitoring community health in data-poor areas. A non-governmental organization called "Community Information and Epidemiological Technologies" (CIET) has worked in collaboration with the WHO to develop a method of Sentinel Community Surveillance (SCS) for use in developing countries. While the focus has been primarily in data-poor countries of the South, recent work has also focused on issues closer to home such as smoking among Canadian Aboriginal youth[63] and environmental issues affecting youth in Brooklyn.[64] With a stated goal of "Building the community's voice into planning" the organization uses intensive cluster sampling techniques and community-directed investigation and reporting at a local level, while feeding information into national surveillance systems. CIET is currently undertaking a project in Canada called LoPHID (Local Public Health Information Development) which seeks to build local health information systems. The current plan is to implement a pilot in 5-10 regions in the country. This type of decentralized approach -- building local capacity for data collection and management -- linked with a more central reporting and surveillance network may have potential for use in Ontario.

It should be noted that this analysis only tests the stability of the estimate for each indicator. The stability of the indicators assessed here at the PHU-level indicates the degree of confidence that the estimate reliably represents the actual proportion of cases in the population as a whole, or the average risk across the PHU. As the analysis in Chapter 4 suggests, statistical stability at the PHU-level, does not imply that the estimate is representative of the communities within the PHU, given the fairly high degree of variability among CSDs.

3. Timeliness

Timeliness is a characteristic of the data set rather than the indicator itself. Indicators should be based on data which are reasonably up-to-date. Longitudinal data are also very useful in monitoring time trends and assessing the impact of policies or programmes. There are two main considerations in assessing the availability of timely data: frequency and lag time.

The frequency of routine data collection will determine how current the available data are. Data from government ministries such as transportation and labour force data, as well as data from registries such as cancer incidence and mortality, are generally available annually. Census data are available every five years, and survey data are generally irregular or one-time collections.

Lag time is also important. This is the time lapse between data collection and their availability to users. Although registry data are collected every year, it can take two to three years before those data are processed and made available. This is fine for retrospective longitudinal analyses, but does mean that up-to-the-year data are not available from these sources. For indicators such as mortality rates and cancer incidence, lag time just adds to an already long-term evaluation process, given the chronic nature of the intervention-outcome relationship. For other indicators such as air quality or, to a lesser extent, behavioural outcomes, lag time is a more serious concern in the assessment of more rapidly changing phenomena.

Research Question #5: What is the frequency and lag time for reporting of each OCHP indicator?

Frequency

The frequency with which new information on indicators becomes available is summarized by OCHP category in Table 5.5.

Table 5.5 Number of indicators available by frequency within OCHP categories

category	number of indicators				
	total	annual	census years	irregular	one-time survey
demographic	11	2(+4 est)	9	-	-
economic	10	4	5	-	1
social	8	1	1	1	5
physical environment	5	5	-	-	-
health-related practices	11	-	-	-	11
health status	21*	16	-	-	4
total	66	28	15	1	21

* includes one unknown (dental index)

Of the 66 indicators, 28 are available annually, 19 are available in census years, one is available irregularly, and 17 are taken from a one-time survey. The frequencies for each OCHP category are discussed below.

Of the 11 demographic indicators, two are available annually and nine are available each census year. Of those nine indicators, four are estimated annually, but only at the PHU level. There are 10 economic indicators, of which five are available for census years, four are available annually, and one is available only from the OHS. Of the eight social indicators, four are from the OHS, available only for 1990. Adult literacy is based on a 1989 survey and is available only for that year. Voter participation is available irregularly (whenever there is an election), and average number of persons per room is available for census years (every five years). The only social indicator available on an annual basis is the violent crime rate, which is also available monthly. All of the five physical environment indicators are available on an annual basis. Most are available more frequently -- often daily or monthly -- as they are collected routinely as part of ongoing environmental monitoring programmes. All of the 11 health-related practices indicators are from the OHS and are only available for 1990.

Many of the health status indicators are available on an annual basis. The main exceptions are those based on the OHS: self-perceived health, chronic health problems, contemplated suicide, and prevalence of long-term disability, which are available only for 1990. As discussed above, the dental index is being altered. It was done every two years until 1989-90, after which it was repeated in 1994. Plans are to do the survey in junior and senior kindergarten every year to identify high risk children (Dr. Sandra Bennett, personal communication). Overall, of the 21 health status indicators in the OCHP, 16 are available annually, four are available for 1990 only (OHS), and one (dental index) is presently an undetermined frequency.

Lag Time

Although data may be collected annually, most of the registries require a two to three year lag period before data are fully collected and compiled. Detailed census data require a lag period of around two years. Thus, although a census is taken every five years, data may be up to seven years old (as is the case at the time of writing this report -- data from the 1996 census became available in May of 1998). Lag times for routinely collected statistics such as unemployment rate and physical environment readings are considerably smaller. Certain measurements from Environment Canada (for example UV readings) are available almost instantaneously over the Internet. For survey data such as the OHS, the 'lag time' increases with each passing year. In 1997, the data are already seven years old. In terms of both frequency and lag time the reliance of the OCHP on OHS data makes its timeliness poor.

4. Format

The format in which data are available will also affect the practicality of the indicator. The move toward centrally available databases in electronic form is intended to facilitate access to current and relevant data. The Ontario Health Planning System (HELPS) is an example of an attempt to provide a wide range of relevant data in electronic form from one central location. Centres such as the Health Information Partnership for Eastern Ontario, acting as a data clearinghouse, also provide epidemiologic and statistical references and resources. If issues of confidentiality and equal access to necessary hardware are addressed, the application of Internet and software technologies has great potential to improve access to data in ready-to-use format.

Research Question #6: Which OCHP indicators are available from a central database in electronic format?

Most of the data are available in electronic format from a central database. However, there are some exceptions. The number of people receiving food from food banks is not centrally available in the economic category. Data on extent of green space are not available centrally. The extent to which they are available locally varies. As part of its recent Natural and Open Spaces Study (NOSS) and its Greenway Project, the City of Ottawa is able to provide detailed information on land use and accessibility of green space.[65,66] However, few municipalities have such a well-developed system of accounting for green space. A few indicators such as violent crime rates and UV readings are available from either local sources (police stations and weather offices respectively) or from central sources. Local sources may be more readily available to health units but data from a number of independent sources (often municipalities) may lack the standardization necessary for comparison across a unit.

The HELPS databases currently use three different geographic coding protocols: census codes, geocodes, and health unit codes. This unnecessarily complicates data linkage at the health unit level. Ensuring that data in the province were coded under a common system would greatly assist health planners in using the data that are available.

Another concern is the consistency of coding between databases. As is apparent in the CSD-level analysis in Chapter 4, more than half of the CSDs in Eastern and Leeds, Grenville, Lanark health units had mismatched mortality and census data, due to inconsistencies in mortality CSD coding. This specific problem is being dealt with currently, but care should be taken to safeguard the consistency of geographical codes in the databases.

5. Parsimony

A profile should be concise as well as comprehensive, maximizing coverage while placing limits on the number of indicators used. The WHO suggests 30 indicators as an upper limit.[67] The Canadian Health Information System and OCHP have incorporated upwards of 60, but actually comprise far more values, given that some indicators (for example cause-specific mortality rates) have a number of categories. Identifying redundancies among the indicators is one way of paring down the profile. It is possible that certain indicators may be providing similar information. In such cases, we may not lose much information by eliminating one of the indicators, reducing costs and simplifying the profile.

Research Question #7: What redundancies exist among OCHP indicators?

The conceptual map in Figure 3.2 gives a general picture of the extent to which the indicators of the OCHP cover the community health concept. As described in Chapter 3, there are sub-categories of health status within which indicators appear to be clustered. This section further explores the clustering, using bivariate correlations to identify possible redundancies in the profile.

Methods

As Streiner and Norman[34] point out, using correlations to assess a set of indicators (or items in the case of questionnaire design) is not a straightforward task. High correlations may indicate that indicators are measuring a common dimension, but also reflect redundancies among indicators. Low correlations may mean that indicators are representing a range of divergent dimensions and thus covering more conceptual ground, but may also imply that there is no common underlying theme, or that the indicators may not actually be measuring what they are meant to measure. Thus, it is important to pay careful attention to the types of indicators that correlate strongly. Based on *a priori* beliefs about conceptual relationships among the indicators, the correlation results can be more intelligently interpreted.

The main OCHP indicators of health status (excluding subcategories by age or specific disease/cause of death) were used in the analysis. Crude all-cause mortality rate was used for the category 'leading causes of death'. Indicators excluded from the CV calculations were not used here for the same reasons. The PHU was the unit of analysis. Thus, 42 units were used to calculate the correlation coefficients.

Tests for normality using the Shapiro-Wilk statistic revealed that infant mortality rate (IMR) and perinatal mortality rate (PMR) both had significantly non-normal distributions. Logarithmic transformation served to normalize both distributions. Thus, the correlation coefficients are for $\log_{10}$(IMR) and $\log_{10}$(PMR).

Bivariate correlation matrices were constructed for each group of conceptually clustered variables. The clusters examined here are: *mortality-based measures* (life expectancy, potential years of life lost, crude mortality rate); *measures of hospital morbidity* (average hospital days of stay, average hospital separations, average hospital separations for injury); *infant health measures* (low birth weight, infant mortality rate, perinatal mortality rate); and *measures of chronic/subjective health* (percentage with one or more chronic conditions, percentage with long term disability, percentage in fair or poor self-assessed health). This last category was presented as two separate categories in Chapter 3. However, given that the two categories combined contain only three indicators without indicators excluded from this analysis, and some conceptual similarities, they are treated as a single category here. In this way the analysis may also suggest whether self-perceived health is actually measuring a separate dimension from the other chronic measures. Specific measures such as suicide mortality and motor vehicle mortality are left out of the analysis as they have unique policy implications (for example, the need for youth programs and road legislation) and therefore need to be included regardless. Pearson correlation coefficients were calculated for each pair of variables, and tested for two-tailed significance with α=0.05.

Results

Tables 5.6 - 5.9 present the bivariate Pearson correlation coefficients for indicators within each category: mortality, hospital morbidity, infant health, and chronic and subjective health measures respectively. Note that infant health measures are for both sexes.

Table 5.6 *Bivariate Pearson correlation coefficients for mortality-based indicators*

indicator	life expectancy		potential years of life lost (PYLL)		crude mortality rate (CMR)	
	male	female	male	female	male	female
Life expectancy	-	-	-	-	-	-
PYLL	-.90	-.82	-	-	-	-
CMR	-.70	-.49	.71	.50	-	-

Table 5.7 *Bivariate Pearson correlation coefficients for measures of hospital morbidity*

indicator	average number of hospital days		average number of hospital separations		average hospital separations due to injury	
	male	female	male	female	male	female
avg hospital days	-	-	-	-	-	-
avg hospital separations	.71	.72	-	-	-	-
average hospital separations due to injury	.55	.45	.69	.70	-	-

Table 5.8 Bivariate Pearson correlation coefficients for infant health indicators

indicator	log infant mortality rate (IMR)	log perinatal mortality rate (PMR)	incidence of low birth weight (LBW)
log IMR	-	-	
log PMR	.43	-	
LBW	.12	.25	

Table 5.9 Bivariate Pearson correlation coefficients for chronic and subjective health indicators

indicator	% with one or more chronic condition		% with long term disability		% in fair or poor health	
	male	female	male	female	male	female
% chronic condition	-	-	-	-	-	-
disability	.54	.60	-	-	-	-
% fair or poor health	-.11	-.04	.34	.17	-	-

(Note: All correlations greater than .40 are significant at $p<.01$)

Discussion

As expected, the mortality indicators are highly or moderately correlated. These indicators use the same data from the mortality registry and are basically variations in the presentation of identical information. Potential years of life lost and life expectancy are more highly correlated with each other than with crude mortality rate, especially among women. Again, this is as expected, as life expectancy and PYLL both reflect the age at which people are dying whereas crude mortality does not. Given the conceptual similarities, and the high level of correlation between these indicators, it may be sufficient to select one of them to represent general mortality in the community. While crude mortality rate is the simplest of the three to calculate, PYLL may add additional information due to its accounting for age at death. This is reflected in its higher correlation with life expectancy than with crude mortality.

All of the hospital morbidity measures appear to correlate quite highly. Hospital days of stay reflects the severity and type of disease more than hospital separations which is the incidence of hospitalization in the population. Since there are two indicators of hospital separations included in the OCHP, and these are also highly correlated, average all-cause separations is most highly correlated of the three indicators. Thus, this may be the most appropriate of the hospital morbidity indicators to include in a more parsimonious set of community health indicators.

Given that perinatal and infant mortality rates are correlated fairly strongly within the category for infant health measures, these rates may be fairly redundant in providing information on the health of the population. Infant mortality rate may be the more useful of the two for comparing with other regions, given its more common use as a community health measure. Low birth weight, on the other hand, is not significantly correlated with either measure and thus should remain in the profile.

Among the chronic and subjective health measures, percentage of the population with a long term disability and the percentage with a chronic condition are fairly highly correlated. However, with the exception of a moderate correlation with disability in men, self-rated health is not correlated with either factor. The analysis suggests that, as initially hypothesized, self -rated health is measuring a different dimension of health than the existence of chronic morbidity in the population.

Of the four groups of health status indicators, potential years of life lost, prevalence of chronic disease, self-perceived health, infant mortality, incidence of low birth weight and average hospital separations represent a more parsimonious list. Suicide mortality, contemplated suicide, motor vehicle accident mortality, cancer incidence, incidence of notifiable disease, dental index, and immunization status all have specific policy implications and thus should be maintained in a more parsimonious profile. Contemplated suicide and suicide mortality are fairly strongly correlated for males (.50) but not for females (.12). This may reflect the fact that males are more likely to actually commit suicide than are females. Thus, the two suicide measures may be redundant for males, but not for females. Incidence of occupational injuries may be correlated with chronic health and disability measures, but data were unavailable for this indicator. From the original 21 health status indicators, a more parsimonious list includes the following 15 indicators:

- low birth weight
- percent in fair or poor self-perceived health
- prevalence of chronic illness
- infant mortality rate
- crude suicide mortality rate
- contemplated suicide
- mortality due to motor vehicle accidents
- potential years of life lost
- average hospital separations
- incidence of major notifiable disease
- incidence of notifiable disease requiring vaccination
- immunization status
- incidence of occupational injuries declared and compensated
- dental index
- cancer incidence

Proxy indicators

A second method of simplifying the profile is to identify proxy indicators or summary indices which represent an entire set or subset of indicators. While most work on proxy indicators has been focused at the national or provincial level, some recent work has examined the use of proxy indicators for regions within provinces.

Various projects have utilised some form of proxy indicator or index to act as a proxy for community health. For instance, the Manitoba PHIS project used premature standardized mortality ratios.[54] Birch, Eyles and Newbold used a standardized indicator of perceived health.[68] More commonly, indicators such as life expectancy have been used to describe the overall health status of a community or country. Life expectancy has been combined with morbidity statistics to create 'health-adjusted life expectancy' (HALE). This has similarities to disability-adjusted life years used by the World Bank to estimate the cost of various health conditions and to evaluate the effectiveness of various health interventions in the developing world.[69] While most work on proxy indicators has been focused at the national or provincial level, some recent work has examined the use of proxy indicators for regions within provinces. This study examines five such measures: health adjusted life expectancy, self-perceived health expectancy, life expectancy, potential years of life lost, and the standardized premature mortality ratio.

Manuel has calculated the health adjusted life expectancy for Ontario PHUs based on the 1990 OHS and Statistics Canada data.[70] The HALE is a composite index which uses the Health Utilities Index to adjust life expectancy calculations.[71] The Health Utilities Index is derived from surveyed preferences for health states based on eight attributes: vision, hearing, speech, ambulation, dexterity, cognition, pain, and emotion. Beyond showing a fairly high correlation with life expectancy and self perceived health expectancy (expected number of years in very good or excellent self-perceived health), Manuel's paper does not test the HALE against a broader spectrum of health status measures. As it uses OHS data on disability and chronic health conditions, HALE should correlate strongly with these indicators in the OCHP. Manuel has also calculated self perceived health expectancy values for PHUs. This is defined as the average number of years in which one can expect to live in good or excellent health (as determined by the self-perceived health item in the OHS).

The standardized mortality ratio for premature mortality (0-64 or 0-74) is less complex, but has been suggested as an indicator of need for health care services.[72,73] The SMR (0-64) was used by the Manitoba PHIS as a proxy for overall health within the population in the validation of a socioeconomic index.[74] Birch, Eyles and Newbold have tested the correlation of the SMR (0-74) with the standardized ratio of people in fair or poor self-perceived health (which they termed the standardized health ratio) among Quebec regions.[68] They found a significant Pearson correlation of 0.58. In this case, the authors treated the standardized health ratio as a 'gold standard' for the health of the population as whole and did not test the SMR for premature mortality against any other health status indicators. They make the point that the SMR for premature mortality is a good proxy for self-perceived health status as it is based on existing mortality registries as opposed to costly additional surveys.

Research Question #8: What proxy indicators best represent a subset of OCHP indicators?

Methods

A correlation analysis was used to test the extent to which these potential proxy measures represent the OCHP health status indicators. HALE and life expectancy in good health are from Manuel.[70] The standardized mortality ratio for premature mortality (SMR 0-64) was calculated using provincial age- and sex-specific mortality rates based on 1991 mortality registry data, multiplied by the corresponding age- and sex-specific populations in each PHU, based on 1991 census data. Summing across age groups provided the expected number of premature deaths (before age 65) in each PHU, which was then used to divide the observed number of deaths in each PHU, providing the SMR(0-64) for each health unit. For comparison, the crude mortality rate (0-64) was also entered into the correlation matrix. As the SMR(0-74) is also used in some population health assessments, this was also calculated for each PHU and correlated with each health status indicator. Since the results were very similar to those of the SMR(0-64) they are not shown in the tables below.

Normality tests (skewness, kurtosis and Shapiro-Wilk statistic) revealed non-normal distributions for each of these indicators. The non-normal distribution is largely due to one outlier -- the City of Toronto PHU which had a highly elevated premature mortality rate. This is illustrated by the normal probability plots in Figure 5.2.

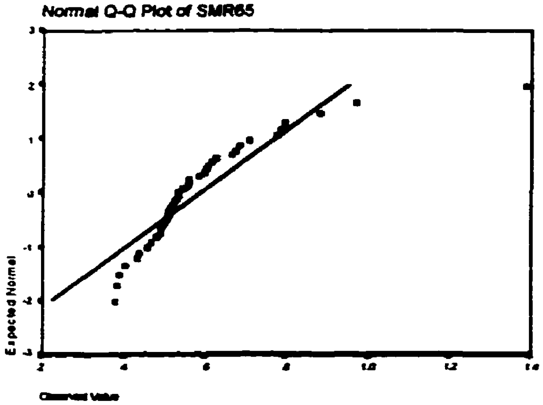


Figure 5.2a Normal probability plot for SMR65 (females)

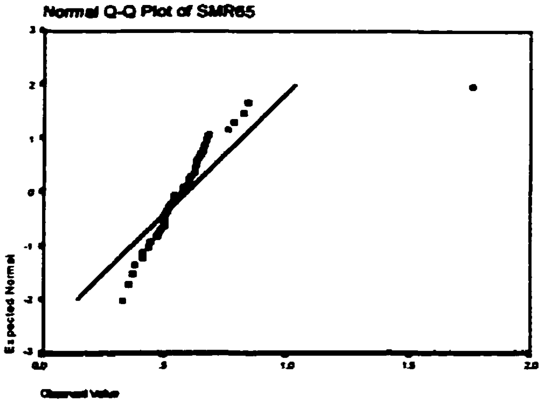


Figure 5.2b Normal probability plot for SMR65 (Males)

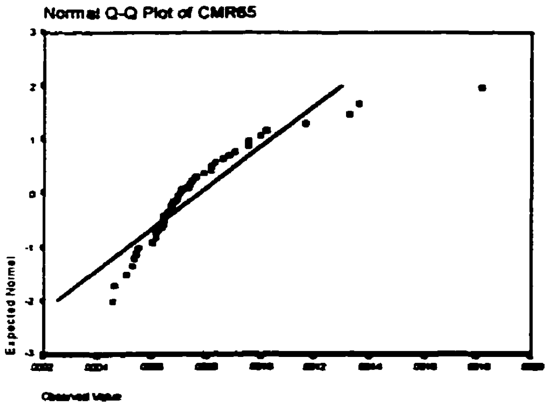


Figure 5.2c Normal probability plot for CMR65 (females)

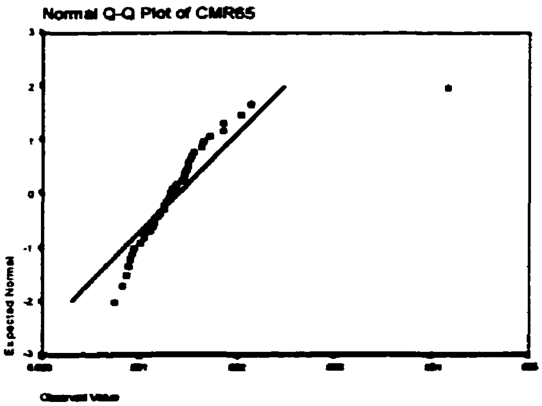


Figure 5.2d Normal probability plot for CMR65 (males)

Removing Toronto PHU from the data set resulted in fairly normal distributions for premature SMR and CMR. Note that the 'City of Toronto' health unit refers only to the municipality of Toronto as it existed in 1991 (population circa 600,000) prior to the amalgamation of municipalities that formed the current City of Toronto (population close to three million). Table 5.10 shows values for normality statistics before and after removal of the Toronto PHU datum. Skewness refers to the degree of asymmetry of the normal distribution. A value of zero denotes a symmetric normal distribution. A positive value indicates that the distribution tails to the right, while a negative value indicates that the distribution tails to the left. Kurtosis refers to the level of clustering or 'peakedness' of the graph. A value of zero indicates a normal distribution. Positive values indicate a higher degree of clustering, resulting in a sharper peak and longer tails, while negative values indicate the opposite situation of less clustering, with a 'flatter' distribution and shorter tails. The Shapiro-Wilk statistic (W) is a regression-based measure that tests the association of residuals with the expected normal values. Low values of 'W' (significantly lower than 1) suggest a non-normal distribution.

Table 5.10a *Results of tests for normality before and after removal of Toronto PHU (females)*

Indicator	Before Removal			After Removal		
	skewness	kurtosis	Shapiro-Wilk Statistic	skewness	kurtosis	Shapiro-Wilk Statistic
SMR65	2.44	8.49	0.793	1.14	1.32	0.913
CMR65	2	5.29	0.830	1.28	1.78	0.898

Table 5.10b *Results of tests for normality before and after removal of Toronto PHU (males)*

Indicator	Before Removal			After Removal		
	skewness	kurtosis	Shapiro-Wilk Statistic	skewness	kurtosis	Shapiro-Wilk Statistic
SMR65	3.78	19.66	0.674	0.3	-0.08	0.974
CMR65	3.37	16.41	0.721	0.46	0.02	0.973

In order to compare results with Birch, Eyles and Newbold,[68] percentage in fair or poor health was converted to the self-perceived health ratio (SHR). As with the SMR(0-64) provincial age- and sex- specific percentages in fair or poor health were used to calculate expected numbers in fair or poor health in each PHU. Similarly, the SHR was calculated by dividing the observed number in fair or poor health in each PHU by the expected number based on provincial data. These values were then correlated with the summary measures.

***Table 5.11a** Correlations of summary measures with the female OCHP health status indicators* (1991).

indicator	proxy indicator					
	HALE§	self-perceived health expectancy §	life expectancy	potential years of life lost	SMR (0-64)	premature mortality (0-64)
life expectancy	0.78**	0.30	--	-0.82**	-0.08	0.11
rate of low birth weight	0.14	-0.10	0.15	-0.09	0.29	0.37*
fair or poor perceived health	<0.01	-0.48**	0.16	0.08	0.37*	0.41**
self-perceived health ratio	0.31*	-0.41**	0.46**	-0.19	0.56**	0.66**
chronic health problems	-0.41**	-0.01	-0.31*	0.29	0.08	0.08
all cause mortality rate	-0.35*	0.09	-0.49**	0.50**	0.08	0.07
log infant mortality rate	-0.15	-0.22	0.01	0.36*	0.43**	0.35*
log perinatal mortality rate	-0.33*	0.02	-0.16	0.15	0.28	0.31*
suicide rate	-0.18	-0.18	-0.25	0.40**	0.18	0.08
contemplated suicide	-0.49**	-0.07	-0.52**	0.43**	-0.09	-0.16
mva injury mortality rate	-0.45**	-0.02	-0.43**	0.47**	-0.04	-0.13
pyll	-0.73**	-0.39*	-0.82**	--	0.41**	0.23
total hospital separations:	-0.24	-0.13	-0.24	0.37*	-0.02	-0.04
hospital morbidity: injury	-0.35*	-0.01	-0.40*	0.45**	-0.08	-0.15
total hospital days of stay	-0.20	-0.14	-0.13	0.32*	-0.04	-0.03
long term disability	-0.44**	-0.20	-0.28	0.40**	0.18	0.13

* correlation is significant at the .05 level (two-tailed)
** correlation is significant at the .01 level (two-tailed)
§ 1990 data from Manuel (1997)

***Table 5.11b Correlations of summary measures with the male OCHP health status indicators* (1991)**

indicator	proxy indicator					
	HALE§	self-perceived health expectancy §	life expectancy	potential years of life lost	SMR (0-64)	premature mortality (0-64)
life expectancy	0.83**	0.29	—	-0.90**	-0.19	-0.06
rate of low birth weight	-0.13	0.04	-0.14	0.14	0.34*	0.41**
fair or poor perceived health	-0.30	-0.57**	-0.31*	0.43**	0.46**	0.44**
self-perceived health ratio	0.12	-0.37*	0.14	0.15	0.67**	0.71**
chronic health problems	-0.34*	-0.04	-0.28	0.21	-0.02	-0.04
all cause mortality rate	-0.67**	-0.27	-0.70**	0.71**	0.27	0.24
log infant mortality rate	-0.29	0.02	-0.25	0.32*	0.42**	0.37*
log perinatal mortality rate	-0.15	-0.07	-0.26	0.35*	0.36*	0.40*
suicide rate	-0.71**	-0.47**	-0.75**	0.78**	0.45**	0.35*
contemplated suicide	-0.58**	-0.11	-0.56**	0.59**	0.28	0.22
mva injury mortality rate	-0.36*	-0.08	-0.43**	0.39*	0.03	-0.04
pyll	-0.77**	-0.35*	-0.90**	--	0.50**	0.38*
total hospital separations	-0.37*	-0.34*	-0.39*	0.38*	0.07	0.06
hospital morbidity: injury	-0.12	-0.03	-0.21	0.18	-0.01	-0.07
total hospital days of stay	-0.30	-0.26	-0.29	0.34*	-0.03	0.04
long term disability	-0.70**	-0.48**	-0.48**	0.46**	0.37*	0.35*

* correlation is significant at the .05 level (two-tailed)
** correlation is significant at the .01 level (two-tailed
§ 1990 data from Manuel (1997)

Results

The Pearson correlation matrices for proxy indicators in males and females are presented in Tables 5.11a and 5.11b. The proxy indicators are listed in order of decreasing complexity from the composite indicators health adjusted life expectancy (HALE) and life expectancy in good health on the left, to PYLL and premature mortality (0-64) on the right. Two patterns seem immediately apparent: the correlations are generally stronger among men than among women, and the simple indicators on the right appear to correlate as strongly or, in men, more strongly than the more complex indices on the left. Detailed observations for each proxy indicator are given below.

HALE: Health adjusted life expectancy correlates highly with life expectancy. This is to be expected as HALE is an adjusted form of life expectancy, and is consistent with Manuel's finding of a high Pearson correlation of 0.77 overall (both sexes combined). HALE correlates moderately or highly with most mortality based measures, except for infant and perinatal mortality. There are high correlations with percentage disability and percentage chronic health problems, which were expected given that both variables relate to the health states which were derived from the OHS and used to calculate the weights for HALE. The correlation with contemplated suicide is also high in both sexes. What is more surprising is the lack of correlation with self-perceived health. Given the extent to which HALE incorporates chronic and self-reported health states, and weights based on preferences for those states, one would expect at least a moderate level of correlation with this indicator.

Self-Perceived Health Expectancy: Unlike HALE, self-perceived health expectancy correlates quite strongly with percentage in fair or poor self-perceived health, but appears to correlate with little else. The correlation with self-perceived health is to be expected as the same OHS data were used in the calculation of both indicators. While there are a few other significant correlations -- with PYLL in both sexes and with disability, hospital separations, and suicide rate in males -- there is not a convincing pattern or strength of relationship with the OCHP indicators here.

Life Expectancy and PYLL: As expected, these mortality-based indicators were highly inter-correlated (0.90 and 0.82 in men and women respectively) and correlated strongly with other mortality-based indicators in the profile, with the exception of infant and perinatal mortality. Both also correlated strongly with contemplated suicide. Both were fairly strongly correlated with disability, with the exception of life expectancy in women. It is interesting to note that both indicators correlated moderately with self-perceived health in men, but not in women, although life expectancy is moderately correlated with self-perceived health ratio in women.

SMR(0-64) and CMR(0-64): SMR and CMR for premature mortality had similar patterns of correlation with the OCHP health status indicators. Correlation with mortality based measures was generally low. While this may seem surprising, it should be noted that premature mortality (0-64) represents only 25% of overall mortality in Ontario (31% in males and 19% in females). Mortality measures which are conceptually associated with premature mortality (infant mortality, suicide mortality in men, and potential years of life lost) correlated more strongly with premature CMR and SMR. Consistent with Birch, Eyles and Newbold (1996) there were high correlations (0.67 and 0.56 in men and women respectively) between premature SMR and self-perceived health ratio (the authors of that study found a correlation of 0.58 for Quebec regions in 1987). There are few other correlations of note. There do not appear to be any significant correlations with hospital-based measures or prevalence of chronic health problems. There is a significant but not high correlation with prevalence of disability among males.

Discussion

Health adjusted life expectancy did correlate strongly with a number of the OCHP health status indicators and thus may be a good proxy indicator for health status in the profile. One limitation of HALE is its weak correlation with self-perceived health. As it is based partly on survey data (in this case OHS data) HALE does not offer the advantage of being a simpler and more readily available proxy measure, even though it may be a useful summary measure, representing a range of mortality and morbidity measures in the OCHP.

Premature SMR correlates strongly with self-perceived health. It also has the advantage of being based on more readily available mortality statistics, rather than survey data. However, it is not strongly correlated with other OHS or hospital-based variables. While it has been used to represent overall health status based on its strong correlation with self-perceived health,[68] it should be used in conjunction with other indicators for a more comprehensive picture of health status in the community. In places where relevant survey data are not available, premature SMR may be the best proxy indicator as it does appear to reflect more positive health outcomes than simply death in the community. Given that HALE correlates weakly with self-perceived health, and is not significantly correlated with premature SMR (-.12 and -.10 among men and women respectively) using both indicators may provide a more comprehensive measure of health status.

Regression Analysis of the More Parsimonious Set of Health Status Indicators

Having selected two possible proxy indicators, it is possible to compare the complete set of OCHP health status indicators with the more parsimonious set identified in the correlation analysis of redundancies. This regression analysis estimates the amount of variance in each proxy indicator explained by the OCHP health status indicators. The amount of variance explained by the original set compared with the amount of variance explained by the more parsimonious set indicates how much explanatory power is lost in creating a more parsimonious set. Thus, the costs of losing explanatory power can be compared with the benefits of having fewer indicators for which data must be collected. A major limitation of this analysis is the fact that the proxy indicators used only incompletely represent a full definition of health. Thus, the results should be interpreted with the caveat that the indicator set is being assessed based on its ability to predict the value of an imperfect proxy indicator.

Methods

Indicators from the original set of OCHP health status indicators were entered into two multiple linear regressions: one for health adjusted life expectancy (HALE) and one for premature SMR. As identified in the correlation analysis, infant mortality rate and perinatal mortality rate had non-normal distributions and have been entered as log transformed variables. Incidence of notifiable disease, cancer incidence, incidence of occupational injury, dental index, and immunization rate were not entered due to lack of data or incomplete data in the HELPS data set. Thus, the original models are as follows:

$$HALE = \beta_0 + \beta_1[\text{life exp}] + \beta_2[\text{LBW}] + \beta_3[\text{self-perceived health}] + \beta_4[\text{chronic illness}] + \beta_5[\text{CMR}] + \beta_6[\log(\text{IMR})] + \beta_7[\log(\text{PMR})] + \beta_8[\text{suicide mortality}] + \beta_9[\text{contempl suicide}] + \beta_{10}[\text{MVA mortality}] + \beta_{11}[\text{PYLL}] + \beta_{12}[\text{hospital days}] + \beta_{13}[\text{hospital separations}] + \beta_{14}[\text{injury hosp seps}] + \beta_{15}[\text{disability}]$$

and

$$SMR65 = \beta_0 + \beta_1[\text{life exp}] + \beta_2[\text{LBW}] + \beta_3[\text{self-perceived health}] + \beta_4[\text{chronic illness}] + \beta_5[\text{CMR}] + \beta_6[\log(\text{IMR})] + \beta_7[\log(\text{PMR})] + \beta_8[\text{suicide mortality}] + \beta_9[\text{contempl suicide}] + \beta_{10}[\text{MVA mortality}] + \beta_{11}[\text{PYLL}] + \beta_{12}[\text{hospital days}] + \beta_{13}[\text{hospital separations}] + \beta_{14}[\text{injury hosp seps}] + \beta_{15}[\text{disability}]$$

These regressions were run separately for males and females. Regression coefficients for each factor and goodness-of-fit (R^2) were calculated.

Subsequently, regressions were run entering only the variables identified earlier as the more parsimonious set. The parsimonious models are as follows:

$$HALE = \beta_0 + \beta_1[\text{LBW}] + \beta_2[\text{self-perceived health}] + \beta_3[\text{chronic illness}] + \beta_4[\log(\text{IMR})] + \beta_5[\text{suicide mortality}] + \beta_6[\text{contempl suicide}] + \beta_7[\text{MVA mortality}] + \beta_8[\text{PYLL}] + \beta_9[\text{hospital separations}]$$

and

$$SMR65 = \beta_0 + \beta_1[\text{LBW}] + \beta_2[\text{self-perceived health}] + \beta_3[\text{chronic illness}] + \beta_4[\log(\text{IMR})] + \beta_5[\text{suicide mortality}] + \beta_6[\text{contempl suicide}] + \beta_7[\text{MVA mortality}] + \beta_8[\text{PYLL}] + \beta_9[\text{hospital separations}]$$

Again, these regressions were run separately for males and females, calculating regression coefficients for each factor and goodness-of-fit. Comparing the R^2 value for the models using the original indicator set with the R^2 value for the parsimonious set indicates the difference in percent explained variance between the two sets of indicators. In other words, the difference in R^2 values indicates the amount of variance in the proxy indicator explained uniquely by the excluded variables. This is the 'cost' of excluding those indicators.

Assumptions and Limitations of the Models

A central assumption of any linear regression is that the linear model is an appropriate model for the relationship between Y and the independent variable(s). As an initial screening tool, each independent variable in the regression models was plotted against the dependent variable HALE or SMR. These scatterplots did not suggest any significant non-linear patterns for the bivariate relationships. This is not a watertight method for assuring the appropriateness of a linear model as non-linear relationships may emerge once covariance is taken into account in the multivariate model. However, it provides an initial indication that the linear model is not inappropriate. Following the regression, a plot of the residuals ($\varepsilon_i = Y_i - \beta_0 - \beta_1 X_{1i} - \ldots - \beta_p X_{pi}$) versus the fitted values of Y should lack any systematic pattern if the linear model is appropriate.

The model also assumes that the dependent variable is normally distributed. This was tested using the Shapiro-Wilk statistic as well as measures of skewness and kurtosis. As already discussed, the Toronto PHU is a significant outlier in the premature SMR data. As with the correlation analysis, this data point was removed from the analysis. With the point removed, premature SMR assumes a more normal distribution (see Table 5.10). HALE is normally distributed.

The residuals ε_i should be normally distributed with a mean of 0. This is tested following the regression with a normal probability plot.

Collinearity can result in unstable estimates of β as two or more collinear variables could be contributing to the same variance in the dependent variable. Collinearity is likely a problem for the original set of indicators, given the redundancies it was hypothesized to contain. This is borne out by low tolerances for the variables which were removed in the correlation analysis. Tolerance is defined as the variance in Y explained uniquely by a given explanatory variable in a multivariate model. A commonly used measure of collinearity is the reciprocal of tolerance, the variable inflation factor (VIF). VIF is calculated for variable j as $VIF_j = (1-R_j^2)^{-1}$ where R_j^2 is the proportion of the variance of each factor j explained by the remaining factors in the multivariate model. VIFs above 10 indicate a serious problem with collinearity which may affect coefficient estimates.[75] Some indicators produced VIFs between 10 and 13 in the original models. In the parsimonious models, VIFs were all below 3 for women and below 3.7 for men. Thus, while collinearity is a problem in modelling the original set of indicators, it does not appear to be a serious concern in the parsimonious models. Collinearity is not as much a problem for the goodness-of-fit of the model as it is for the individual regression coefficient estimates. As this analysis is focused on the overall goodness-of-fit (R^2) of the various models, collinearity is a less serious concern.

Results

Figures 5.3a-d present plots of residuals versus the dependent variable HALE or premature SMR for male and female parsimonious models. The lack of a systematic pattern in these graphs suggests that the linear function is an appropriate model for these variables.

Table 5.12 presents the R^2 values and beta coefficients for each model using the original and parsimonious sets of indicators. Among males, the parsimonious model explains approximately 76% of the variance in HALE, as opposed to 90% explained by the original OCHP health status indicators. Among females, the parsimonious indicator set explains 66% as opposed to 86% of the variance in HALE. The explained variance in SMR65 is lower, dropping from 76% to 56% in males, and from 64% to 60% in females when the parsimonious indicator set is used. Thus, the eliminated indicators uniquely account for between 4% (in the female SMR65 model) and 20% (in the female HALE model and male SMR65 model) of the explained variance in proxy indicators.

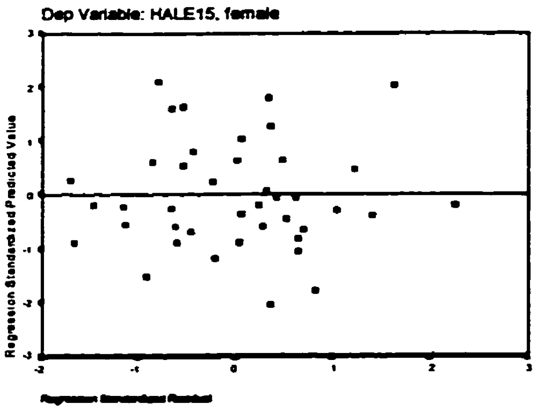


Figure 5.3a Plot of standardized residuals against HALE, female model.

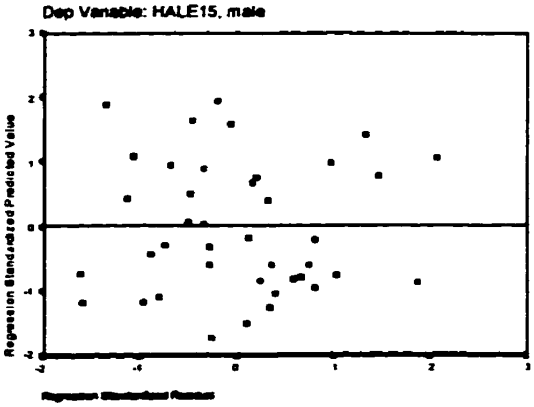


Figure 5.3b Plot of standardized residuals against HALE, female model.

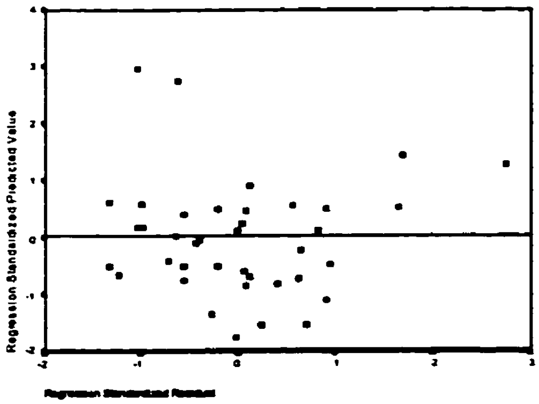


Figure 5.3c Plot of standardized residuals against premature SMR, female model

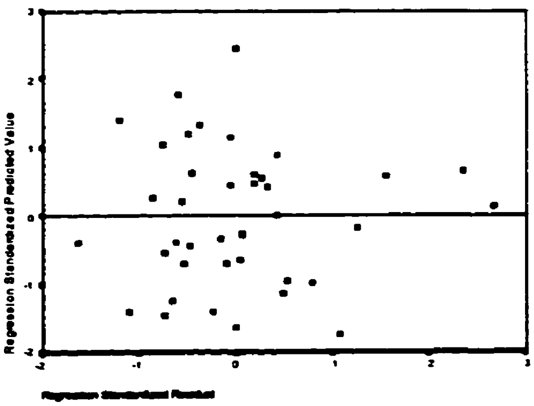


Figure 5.3d Plot of standardized residuals against premature SMR, male model

Table 5.12 ***R^2 values and beta coefficients for original and revised (parsimonious) sets of indicators entered into multiple regression models for HALE and SMR65 in males and females.***

	HALE model				SMR65 model			
	males		females		males		females	
	original	revised	original	revised	original	revised	original	revised
R^2	0.9	0.76	0.86	0.66	0.76	0.56	0.64	0.6
standardized regression coefficients								
constant	23.2	60.9	26.1	67.7	-4.4	0.12	-2.5	<0.1
life expectancy	0.58	--	0.64	--	1.08	--	0.44	--
LBW	0.1	0.1	0.18	0.12	0.14	0.24	0.14	0.28
self-assessed health	0.12	0.11	-0.1	<0.1	0.1	0.28	0.13	0.24
% with chronic health conditions	0.1	<0.1	-0.1	-0.2	-0.3	-0.2	0.1	<0.1
CMR	0.12	--	0.27	--	0.39	--	<0.1	--
log IMR	0.21	0.15	0.15	0.1	0.27	0.34	0.19	0.21
log PMR	-0.2	--	-0.4	--	-0.1	--	<0.1	--
CMR: suicide	<0.1	-0.2	0.14	0.1	0.1	<0.1	-0.2	-0.1
contemplated suicide	-0.2	-0.2	<0.1	-0.2	0.1	0.1	-0.4	-0.4
CMR: motor vehicle accidents	0.12	0.11	-0.2	-0.2	<0.1	-0.1	-0.2	-1.2
PYLL	-0.1	-0.5	-0.2	-0.5	1.13	0.46	1.11	0.75
hospital days of stay	-0.2	--	<0.1	--	-0.1	--	<0.1	--
hospital separations	<0.1	-0.3	<0.1	<0.1	<0.1	<0.1	<0.1	-0.3
hospital separations: injury	-0.2	--	0.1	--	-0.2	--	-0.3	--
disability	-0.4	--	-0.2	--	1.21	--	<0.1	--

Discussion

The role of the proxy indicators in this analysis is not to provide a 'gold standard' for validation of the profile. Rather, they provide a common benchmark against which the original and parsimonious sets of indicators may be compared. As incomplete proxies, they should be fully explained by a comprehensive set of indicators, but should not be expected to fully explain that set. Thus, a reduction in R^2 indicates a potential problem, but no change in R^2 dces not necessarily indicate that no information has been lost by using the parsimonious set of indicators. For example, consider an indicator that is relevant to our understanding of community health, but is not related to HALE or SMR(0-64). The removal of this indicator will reduce the relevance of the set of indicators, but the R^2 will be unaffected.

However, at present, these proxy indicators represent the closest we can come to a comprehensive proxy indicator of community health. When and if more comprehensive indices of community health are constructed, more rigorous empirical validation of the community health profile will be possible.

The high initial R^2 values for HALE in general indicate that this proxy indicator is fairly specific to the indicators in the profile. In other words, most of the variance in HALE is explained by the OCHP indicators. However, the low beta values for many of the indicators (suggestive, but not conclusive given the high degree of collinearity present), and the low correlation coefficients for many of the indicators in the previous analysis underscore the fact that it is also not reflecting the entirety of the profile. Thus, variables relevant to a broader definition of health, but not related to the areas of health represented by HALE may be eliminated from the model without significantly affecting the overall R^2 value. The same may be said for premature SMR, although the initial R^2 values suggest that it is less specific to the indicators in the profile than HALE. Likewise, disproportionate weight is given to indicators directly related to the proxy indicators.

Given that the initial models demonstrated high collinearity which was largely eliminated in the parsimonious models, this is evidence that the parsimonious models represent a significant reduction in redundancy . However, the cost in terms of explained variance is a fairly substantial drop in R^2 (20%) for the female model of HALE and the male model of premature SMR when the parsimonious set of indicators is used. This represents a higher than expected proportion of the variance being uniquely explained by the variables that were eliminated from the profile. Thus, the parsimonious set of indicators appears to reduce redundancy substantially, but with a moderate cost to the explanatory power of the profile. The actual degree of this loss is impossible in the absence of more comprehensive measures of community health.

Chapter 6

Conclusions and Recommendations

Assessing the quality of a community health profile is not a simple exercise. The process is fraught with assumptions and hampered by data limitations. How communities understand 'community health' is so closely tied with fundamental values, beliefs and world-views that definitions will likely remain as diverse as our understandings of what constitutes a 'good' human society. This reality should not be seen as a reason to abandon the exploration, but rather an invitation to continue to engage in an iterative process of refining indicators and discussing the concepts they represent. This thesis has reviewed and defined a framework for evaluating community health indicators that attempts to incorporate some of these concepts. The framework makes a number of assumptions about the nature of community health and the purpose of a community health profile.

One of the assumptions made in this thesis is that the Ontario Community Health Profile will be used to measure an underlying construct of community health within Ontario public health units. Based on this assumption, indicators have been evaluated primarily on the basis of what they tell us about the general state of community health, rather than their utility for other purposes such as screening individuals or early warning of specific disease outbreaks.

Also inherent in the assumption that health units will use the profile to describe a general state of community health the overall make-up of the profile is as important as the validity of each individual indicator it contains. This included the examination in Chapter 3 of possible biases toward particular types of indicator and potential 'gaps' in the composition of the profile. Given the breadth of the empirical evaluation, there are limitations to the depth of analysis of each criterion. These limitations and more detailed interpretation of the results have been discussed following each analysis in Chapters 3 through 5.

Conclusions

Based on a review of the literature and various models of community health, This thesis has defined community health as more than simply the absence of disease or disability among a collection of individuals. Rather, health must encompass both disabling and enabling characteristics that are related to coping ability. Measures of these factors have been defined here as measures of negative or positive health. Moreover, *community* health indicators should encompass levels of measurement that are global and environmental (representing health 'of' the community) as well as aggregate measures (representing health 'in' the community). The community health framework — with axes representing the definition of health and the level of community — is intended to classify indicators according to these two important dimensions.

In the main, existing indicators of health, including those in the Ontario Community Health Profile, appear to be oriented toward a biomedical approach to community health — negative measures of health 'in' the community. As such, they may not represent a satisfactory set of indicators from other philosophical orientations within public health such as community development and distributive justice perspectives.

Given the diversity of communities within each health unit, indicator values reported as aggregate measures at the public health level may not be very representative of those communities. This conclusion is supported by an analysis of standardized incidence rates and chi-square values for the distribution of cancer and mortality within Eastern Ontario health units. Data limitations do not permit a thorough analysis of other indicators, but it is likely that a similar pattern exists for other measures. It is also likely that a similar pattern can be found in other Ontario health units.

Analysis of the availability of OCHP indicators suggested that a heavy reliance on the OHS may be limiting the level of disaggregation at which many indicators are available, as well as their timeliness.. Health status indicators generally provide stable single-year estimates at the health unit level, but five-year estimates may be required for some of the less common phenomena, including cause-specific and age-specific mortality rates such as infant mortality rate and suicide mortality rate.

While the data for most indicators are generally available in electronic format from central sources, there are some coding inconsistencies which limit their utility. This analysis encountered three separate coding schemes — health unit codes, geocodes, and census codes — as well as some serious problems with coding errors at the CSD-level.

Based on overlaps in coverage among the health status indicators, identified through bivariate correlations and confirmed with tests of collinearity, the correlation analysis suggested a subset of 15 indicators. A second approach to increasing the parsimony of the profile is the identification of potential proxy indicators that represent a range of health status indicators. Correlation analysis identified health-adjusted life expectancy and standardized premature mortality ratio as two potential proxies that together appear to be correlated with a number of the health status indicators. Premature SMR has been used as a proxy indicator for community health in previous studies.[74] Health-adjusted life expectancy has only recently been calculated at the PHU-level[70] and has not previously been evaluated against a range of other health unit-level outcomes. Tested against these two proxies, the parsimonious set appears to significantly reduce redundancies, but may also result in a moderate loss of explanatory power.

Based on those conclusions, the following section summarizes recommendations for improving the relevance, representativeness and practicality of the OCHP.

Recommendations

Recommendation 1: Include more measures oriented toward positive health

Given the orientation of the OCHP health status indicators toward negative health measures, the OCHP should include more measures of enabling or 'positive' health outcomes. Possibilities include nutritional measures and indicators of coping capacity.

Recommendation 2: Include community-level indicators of health

Given the orientation of OCHP indicators toward health measures 'in' the community, the OCHP should include more community-level (health 'of' the community) indicators. A table of possible community-level indicators has been included in the discussion section of Chapter 3.

Recommendation 3: Report measures of distribution and diversity in addition to central tendency

The analysis in Chapter 4 suggests that health unit-level rates and means may not represent the diversity of communities within the health unit. Where appropriate and feasible, measures of distribution, in addition to central tendency, should be reported for OCHP indicators. Further study is needed to determine the feasibility of applying measures of inequalities in health, such as the ones tested at the national level in Europe by Makenbach and Kunst[51] and Wagstaffe *et al.*,[50] at the level of the health unit in Ontario.

Recommendation 4: Identify other possible data sources for indicators currently drawn from the OHS

The high degree of reliance on the OHS, to the extent that 20 of the 66 indicators in the OCHP are drawn from that survey, limits the timeliness and level of disaggregation at which indicators are available. Other data sources, such as the National Population Health Survey should be incorporated into the HELPS database. It should be noted, however, that the NPHS does not provide the same sample sizes as the OHS and thus may be even less useful for disaggregated study within health units. It may also be necessary to identify potential proxy indicators for OHS-based indicators. The relationship between standardized premature mortality ratio and self-perceived health, identified previously in Québec[68] and also found for Ontario in this analysis may suggest the use of premature SMR as a proxy indicator where OHS data are not available.

Recommendation 5: Five-year estimates should be used in order to obtain stable estimates for specific mortality rates, including IMR, suicide rate, and motor vehicle accident rate

Cause-specific mortality rates generally produced unstable one-year estimates at the PHU-level as demonstrated by high coefficients of variation (CV). Reporting these rates as five-year estimates will, in most cases, result in CVs within the acceptable range. CV testing of rates and proportions as demonstrated in Chapter 5 may be a useful tool for health units in determining whether one-year or five-year estimates are appropriate.

Recommendation 6: ***A consistent coding system should be used for Ontario public health data***

Data available from the HELPS database are coded in three distinct formats: by health unit, census division and geocode. Converting between these overlapping coding systems is time-consuming and more prone to error than a single coding system. Widespread coding errors for mortality data in two Eastern Ontario health units limited the analysis of representativeness in Chapter 4.

Recommendation 7: ***Redundancies among the OCHP Health Status indicators may be reduced by using a more parsimonious set of 15 indicators***

A more parsimonious list of health status indicators eliminates indicators that were highly inter-correlated within conceptual sub-groups. The list includes low birth weight, percent in fair or poor self-perceived health, prevalence of chronic illness, infant mortality rate, crude suicide mortality rate, contemplated suicide, mortality due to motor vehicle accidents, potential years of life lost, average hospital separations, incidence of major notifiable disease, incidence of notifiable disease requiring vaccination, immunization status, incidence of occupational injuries declared and compensated, dental index and cancer incidence.

Recommendation 8: ***The current list of OCHP health status indicators may be represented by health adjusted life expectancy (HALE) and standardized premature mortality ratio (SMR(0-65))***

As a possible alternative to the parsimonious indicator set, in situations where a summary indicator is desired, standardized premature mortality ratio and health-adjusted life expectancy may be used together to represent the current list of health status indicators.

The findings of this thesis suggest that the above recommendations will help make the Ontario Community Health Profile more relevant, representative and practical. Certainly, more study is required in each of these areas in order to further substantiate and develop the conclusions reached in this thesis. Continuing to work toward an improved OCHP is a contribution toward improved community health in Ontario.

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Appendix 1

Community Health Framework Reviews

This Appendix contains a review of six community health frameworks. Four are theoretical frameworks (Evans & Stoddart 1990, CIAR 1994, POHEM 1992, and the 'Butterfly Model' of community health 1995), and two are operationalized (PHIS 1994 and CHIS 1995). Each framework is described using the terms discussed in chapter 1: health definition (positive/negative) and level of community (health 'in' and health 'of').

Theoretical Frameworks

Evans and Stoddart (Evans and Stoddart 1990)

In their 1990 publication "Producing Health, Consuming Health Care," Evans and Stoddart developed a model of health which has formed the basis for much of Canadian population health measurement in the '90s, including the Canadian Institute for Advanced Research, Manitoba Population Health Information System, and POHEM. Their model stemmed from the Lalonde Report, *A New Perspective on the Health of Canadians* (1974). Evans and Stoddart began by challenging the simplistic notion that health is determined by health care. They examined a range of health determinants, including socioeconomic factors, lifestyles and environment and constructed a more complex feedback model for understanding the dynamics of health.

Definition of Health

The report begins with a critique of the WHO definition of health, arguing that it becomes all-encompassing: very difficult to understand and even more difficult to operationalize. This explains why the definition is often included in rhetoric but rarely in action.

On the other hand, Evans and Stoddart also question the simple biomedical understanding of health as the absence of disease. This approach is far too narrow and does not adequately describe our experience of 'health'.

In seeking a middle ground between these extremes, the authors make a few distinctions:

- **Wellbeing** is included in the model as the ultimate goal of health policy. It is defined as "the sense of life satisfaction of the individual" and is separate from health.
- **Disease** is an externally defined biological condition (as in the simple biomedical definition of health).
- **Illness** is the individual's experience or perception of disease.
- **Health** "is defined in narrow terms but from the patient's perspective, as the absence of *illness* or injury, of distressing symptoms or impaired capacity." Health and Function are paired in the model.

Thus, elements of 'positive health' are incorporated in Evans and Stoddart's model. While the definition is still rather negative ('absence of illness') it does consider subjective health assessment and functional status, moving us away from the simple biomedical 'absence of disease' definition of health.

Level of Community

The model has helped to broaden the discussion of factors affecting health, moving away from an almost exclusive focus on individual choices. The Lalonde Report's emphasis on 'lifestyle' is seen as an attempt to confine the discussion to 'politically innocuous' factors, which shift responsibility away from the state or society and onto the victim. Thus, a harmful activity such as smoking is viewed as simply a lifestyle choice for which the individual is entirely responsible in the absence of any discussion of addiction or wider social determinants of behaviour. Evans and Stoddart begin to account for these broader determinants in the form of economic and social status. However, these collective influences are assessed in terms of their effect on health 'in' rather than health 'of' the community.

The map of the Evans & Stoddart model represents the fact that much of the focus remains on dynamics and outcomes at the individual level (health 'in' the community). The inclusion of dimensions such as health & function, prosperity and well being mean that the model also covers areas of positive health (hence coverage of the lower right quadrant). The model includes social and environmental factors influencing health, but the understanding appears to be more of a health protection approach (focused on negative outcomes and prevention) than a community development or ecosystem health approach (focused on enabling factors, balance, etc). Hence, the map extends mainly into the upper left quadrant, leaving the upper right quadrant largely uncovered.

CIAR Framework on the Determinants of Health (Mustard & Frank 1994)

The Canadian Institute for Advanced Research (CIAR) has developed a framework for understanding the determinants of health in populations. This framework is based mainly on the work of Evans and Stoddart (1990). The CIAR model is the focus of the book 'Why are Some People Healthy and Others Not?: the determinants of health in populations'(Evans et al 1994) considered by many to be the defining work of current population health research.

Definition of Health

Mustard and Frank are not as clear in their definition of health as are Evans and Stoddart. They reject the notion of health as nothing more than health care, and embrace wider social influences on health. However, a clear definition of health appears to be lacking. It is interesting to note the modifications to Evans and Stoddart's 1990 model. Wellbeing has disappeared from the framework, being replaced, it seems, with an expanded view of productivity and wealth, directly influenced by health status and function. Disease has been replaced by 'illness', which raises further questions about the definitions being used, as Evans and Stoddart in 1990 clearly defined health as the absence of illness, distinguishing between illness and disease. Evans and Stoddart also suggested that wellbeing is the ultimate goal of health policy. If that is now missing from the model, does health policy concentrate on 'health status and function', or do 'prosperity and wealth' become markers of successful policy? Throughout the report, life expectancy (in examples of Japanese success) and morbidity (in reference to the Black Report) are used as indicators of health status. Given Evans' role as director of the CIAR Program in Population Health, it is probably safe to assume a similar definition of health to that in Evans and Stoddart's 1990 paper. However, it remains unclear how that definition fits in the current framework.

Level of Community

As in Evans and Stoddart's 1990 report, the CIAR perspective on health incorporates a wide range of community level factors, but concentrates on their impact on health 'in' rather than health 'of' the community.

The map of the CIAR framework in figure 1.2 is quite similar to that of Evans & Stoddart, given the basic similarities between the two models. The CIAR framework is less explicit in its definitions of positive health and so does not extend as far into the right half of the map.

Population Health Model (POHEM) Health Information Template (Wolfson 1992)

The Health Information Template was developed by Michael Wolfson as part of Statistics Canada's Health Information Task Force. It was influenced by the Lalonde and Epp reports, the Santé Quebec health survey structure, and the framework proposed by Evans and Stoddart. The template was designed as an interactive computer software package that would enable health researchers and planners to access data using a structured format that illustrates various domains of population health and begins to address issues of interaction between factors and variation over space and time. POHEM is a microsimulation modeling tool which allows researchers to estimate the effect of health interventions on health-adjusted survival curves in artificial populations. It should be noted that POHEM is not a completely operationalized framework. Elements -- especially the microsimulation of survival curves -- have been developed while some other dimensions of health in the template have yet to be assigned indicators or concrete metrics.

Definition of Health

Health status is included in the framework as one of eight main 'individual characteristics' along with socio-economic status, biological factors, psychosocial factors, cognitive factors, behaviours, exposures/time use, and demographics. The health status box allows a fair amount of scope for measurement of positive health. Clinical disease is just one of six categories comprising health status. There are three functional categories --

impairments, disabilities, and handicaps (the 1991 version of the software lists physical function, mental function, and social function) and a self-report category, each of which could include indicators of both positive and subjective health status. We should note, however, that the POHEM modeling exercises focus on disability-adjusted life expectancies and survival curves, thus placing a strong emphasis on mortality and morbidity statistics.

Level of Community

The structure of the template has individual level outcomes in a 'file folder' format. In other words, the population is a collection of individuals with their own unique characteristics. Thus, interactions in the model appear to occur at the level of the individual. Population health status is then affected through the alteration of health states at the individual level. Health 'in' the community seems to be the focus of the health template. We should note that the model includes a wide range of population level factors (contained within the 'external milieu' and the 'health-affecting interventions' categories). In fact, the interventions section does distinguish between individual and collective level interventions. However, the logic of the model implies that the community factors are important in as far as they affect the individual outcomes. The program is structured to follow fictitious individuals through a simulated life cycle, given a collection of community and individual level variables.

Overall, the framework is quite inclusive to a wide variety of health-influencing factors. However, as the focus is largely on the individual, there is not a clear place for measures of equity or other measures that may be considered health 'of' the community. The software includes a diagram with layers of the framework superimposed, indicating a sensitivity to distribution over time or space. This may then allow for some measures of equity and other spatial measures called for in the geographical literature.

The Butterfly Model of Health (VanLeeuwen & Waltner-Toews 1995)

Developed through the work of the Agroecosystem Health Project at the University of Guelph, the 'Butterfly Model' of Health is an attempt to present a holistic, inclusive view of health. It relates two main domains -- the bio-physical environment and psycho-socio-economic culture -- with external forces, and with each other through the realm of individual body, spirit and mind. The individual realm is enveloped in biological and behavioural filters.

Definition of Health

Healthy individuals and communities hold the two domains in balance. Thus, elements of health balance and potential (Noack 1988) are incorporated, along with sustainability, subjective health dimensions, and a focus on biological elements. The model attempts to focus on interactions, processes and balance rather than actual health 'outcomes': a systemic positive health.

Level of Community

While this version of the model illustrates an individual-centred definition of health, the authors emphasize the importance of including community/population factors such as balance and equity at various levels of aggregation. Communities are viewed as more than simply aggregations of individuals. Thus, we can find unhealthy individuals in healthy populations and healthy individuals in unhealthy populations.

Wall (1995) has attempted a community-focused version of the model. Her definition of community health involves the ability to mobilize resources and tap into 'social capital'.

There are three main levels of organization which contribute to community health: primordial (the interactions that occur within family units), spontaneous (interactions among friends and neighbours), and constructed (formalized organizations such as companies, clubs, and community groups).

The map of the AESH framework in figure 1.2 represents its extensive coverage in all areas of the community health field, with a focus particularly on community level interactions. This is one of the few frameworks which covers the upper right quadrant to any great extent. However, as already mentioned, finding indicators to operationalize this ambitious and extensive framework will be a major challenge.

Operationalized Frameworks

Manitoba Population Health Information System

(Cohen & MacWilliam 1994, Frohlich *et al.* 1994)

The Manitoba Centre for Health Policy and Evaluation was established in 1991 by the provincial government, in association with the Canadian Institute for Advanced Research (CIAR). Through this body, the Population Health Information System (PHIS) was developed. Based on administrative health data for Manitoba, the PHIS is intended to facilitate cross-regional comparisons of health status, socioeconomic risk characteristics, and health care use. While the focus has been largely on services, there is a stated need to "move beyond medical care policy initiatives to health policy initiatives" (Roos & Shapiro 1995). The conceptual model used to design the PHIS is based on Evans and Stoddart (1990).

Definition of Health

Within the larger context of wellbeing, the PHIS adopts a very limited, disease-oriented definition of health. "Health status reflects the absence or presence of disease and functional impairments" (Roos *et al.* 1995). There are two dimensions to health status: disease and health & function. Interaction with wellbeing is mediated through health perceptions. The 102 PHIS indicators are separated into six categories (Cohen and MacWilliam 1994): demographic profile, low birth weight, health care system sensitive indicators, population and cause specific mortality indicators (gender, premature, injury, cancer, chronic disease), hospitalization indicators (injury, cancer, chronic, and infectious disease), and physician visits (disability, functional status, restricted activity days). This categorization seems to be driven more by the availability of indicators than by any underlying concept of the dimensions of health. Certainly, the two main dimensions of disease and health & function are covered in this list, but the theoretical framework does not appear to be the basis for the categories.

Level of Community

While the overall framework includes social, economic, and environmental factors at the community level, these factors are all mediated through "individual response" indicating that the PHIS view of community or population health is one of health 'in' rather than health 'of' the community. Outcomes are to be measured in individuals rather than communities as a whole.

Overall, the PHIS model seems to fit best in Susser's 'black box' paradigm. The map in figure 3.2 shows the clustering of health status measures in the lower left quadrant, reflecting the PHIS's strong biomedical focus. There are few measures of influences on health, and those that are included remain oriented toward health 'in' the community.

CIHI Reference Framework (CHIS) (Working Group 1995)

The Canadian Institute for Health Information (CIHI) is a result of collaboration between Health & Welfare Canada's Health Services & Promotion Branch and the Community Health Information Systems (CHIS) working group (sponsored through the National Health Information Council). CIHI developed a set of 60 community health indicators, based originally on work done by representatives of community health departments in Quebec.

The reference framework used for the CHIS project, based on the theoretical framework for the Canada and Quebec health surveys, has three main levels: Health Determinants, Health Status, and Consequences of Health.

Definition of Health

Health Status is defined as a fairly medical concept in this model. Two main distinctions are made: subjective and objective health status. Subjective health is the personal assessment of health status, while objective health is a 'normative, professional assessment'. Subjective health has no sub-categories while objective health is categorized in the following way:

- mortality
- hospital morbidity
- non-hospital morbidity

Thus, the CHIS model, despite its recognition of the WHO's definition of health, and a stated desire to incorporate elements of positive health, has adopted a fairly biomedical, disease-based definition of health. Social and psychological factors are included as determinants of health, rather than health status.

Level of Community

The CHIS definition and dimensions of health status focus on individual level outcomes. Community level factors are included instead as determinants of health.

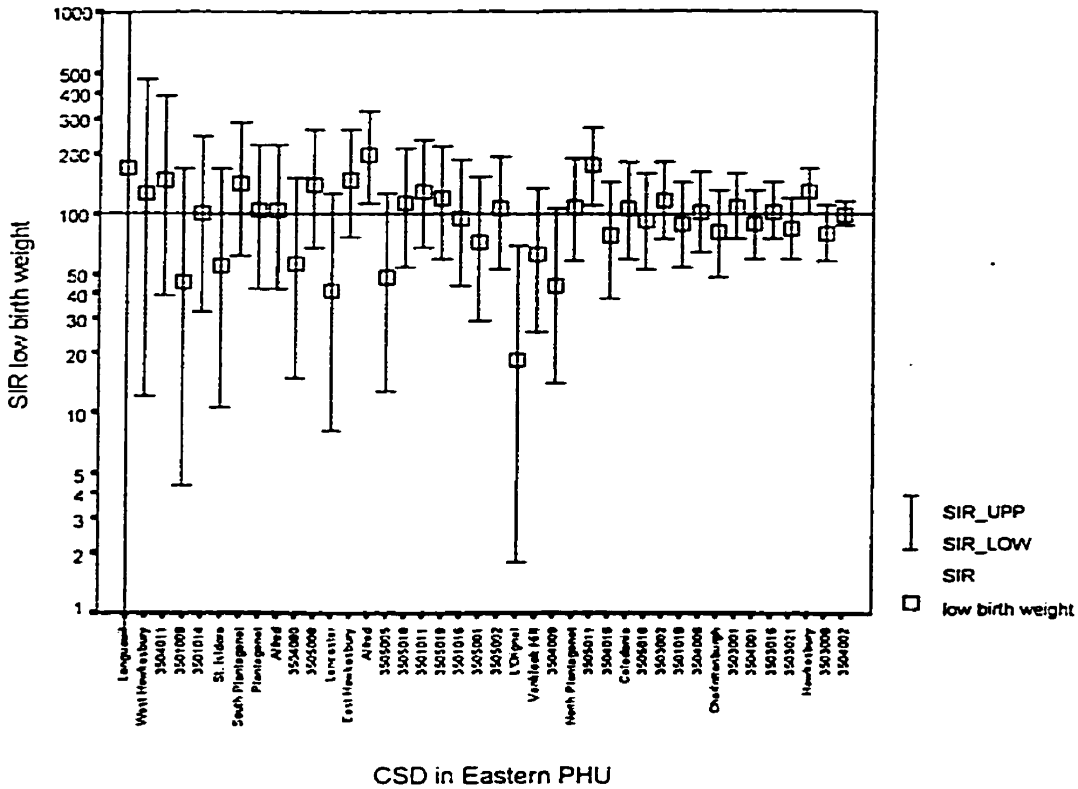
As illustrated by the map in figure 3.2, the CHIS incorporates some more positive measures of health status, broadening its coverage beyond that of the Manitoba PHIS. In addition, there are several influences on health which bring a more population-level and positive health focus to the model. Nevertheless, there remains a dearth of upper right quadrant measures.

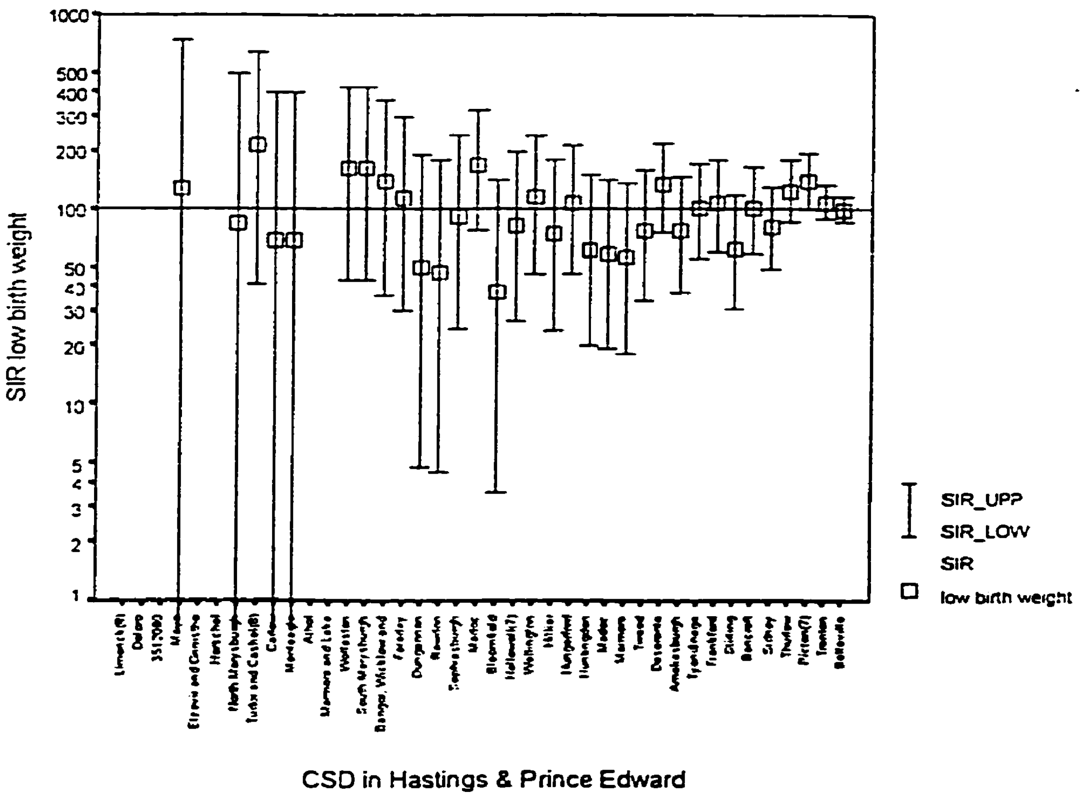
Appendix 2

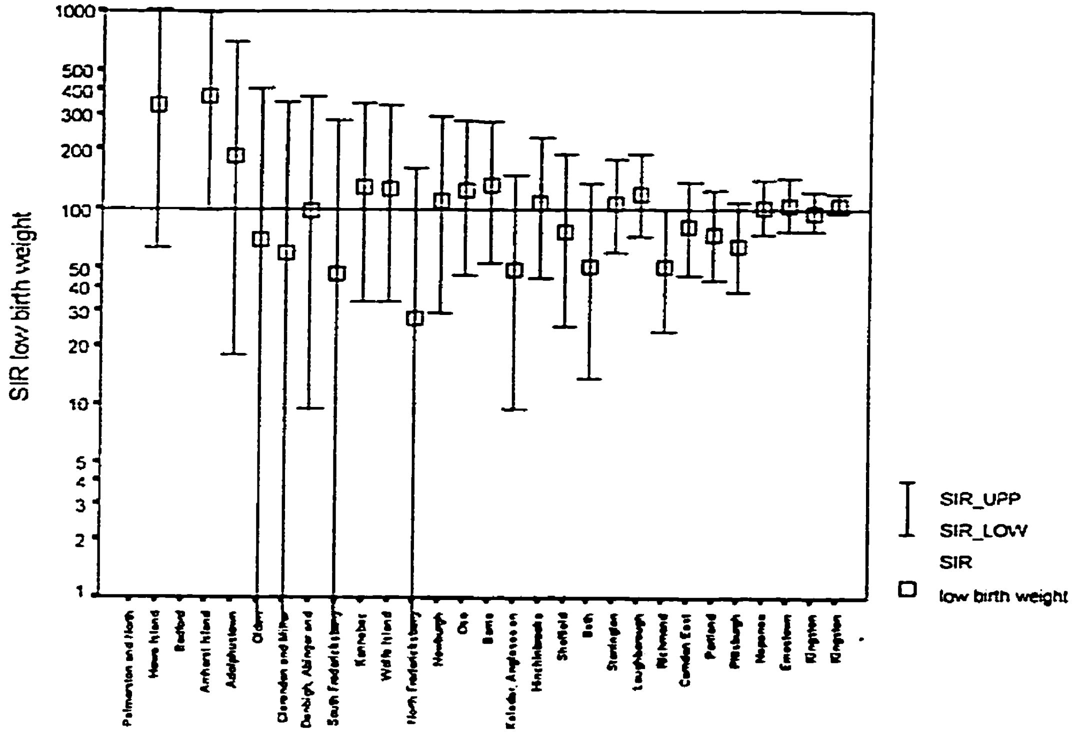
1991 standardized incidence ratios for selected health status indicators by census subdivision for each health unit in Eastern Ontario

Standardized incidence ratios for low birth weight, all-cause mortality, infant mortality, perinatal mortality, potential years of life lost, and cancer incidence are presented for each Eastern Ontario health unit. Rates have been indirectly standardized to the health unit value. Each point represents a census subdivision within the health unit. Error bars represent 95% confidence intervals. The reference line represents SIR = 100% (standardized CSD and PHU rates are equal). Some CSDs did not have value labels in the original data set; these appear as CSD code numbers (e.g. 3512080).

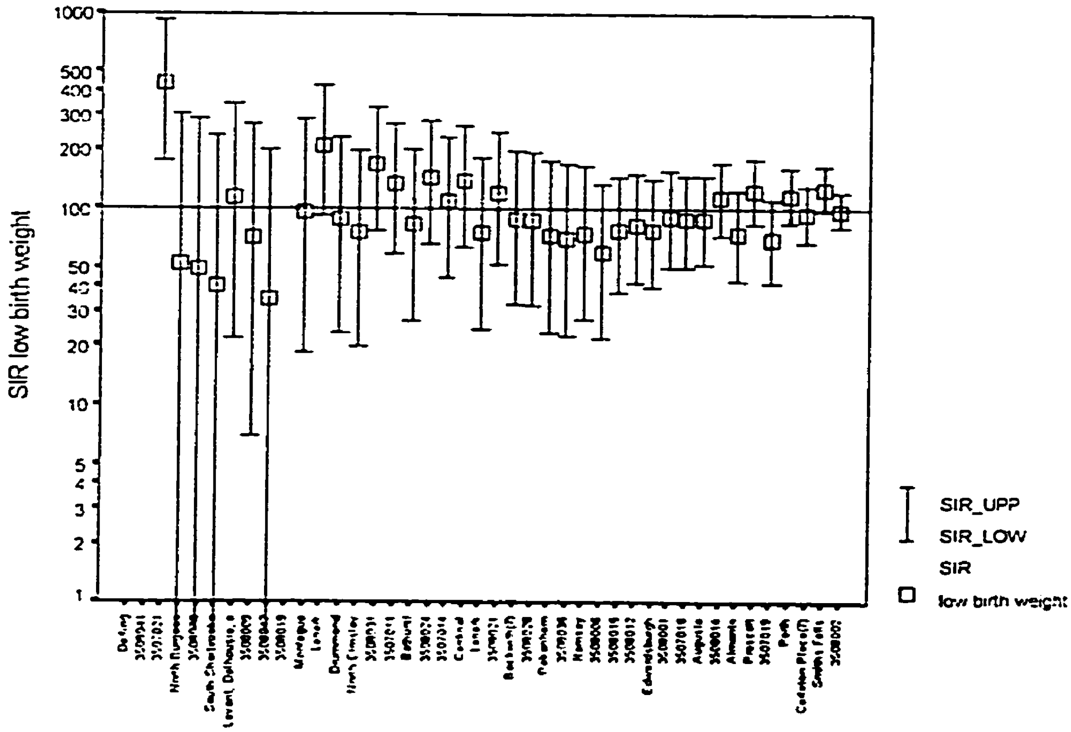
low birth weight: Standardized incidence ratios for CSDs in each Eastern Planning Region health unit, showing 95% confidence intervals. Rates are standardized to the health unit value of the indicator.



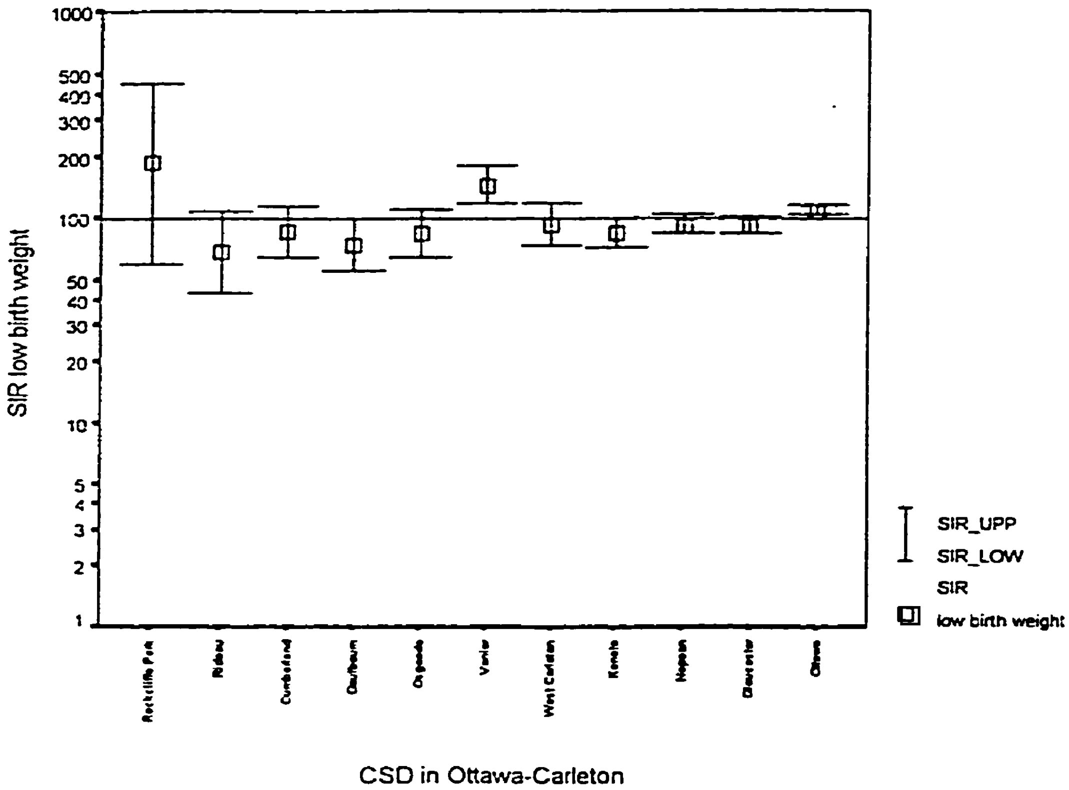




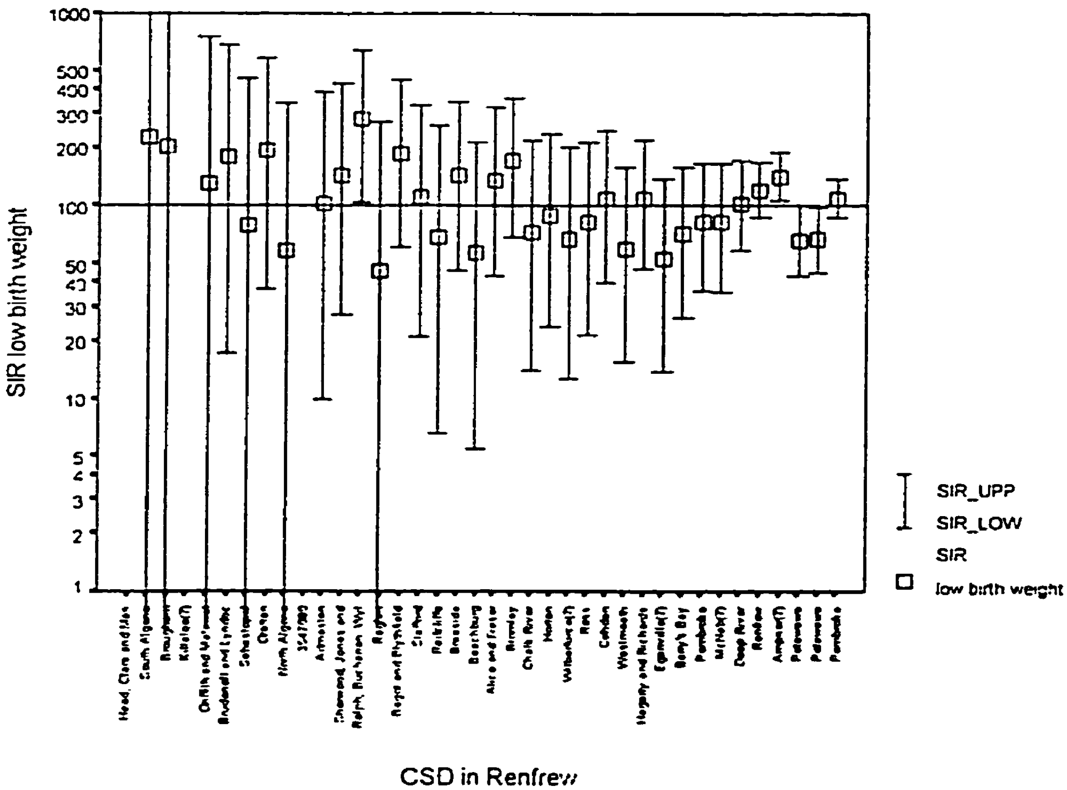
CSD in Kinsgton, Frontenac, Lennox & Addington



CSD in Leeds, Grenville, Lanark

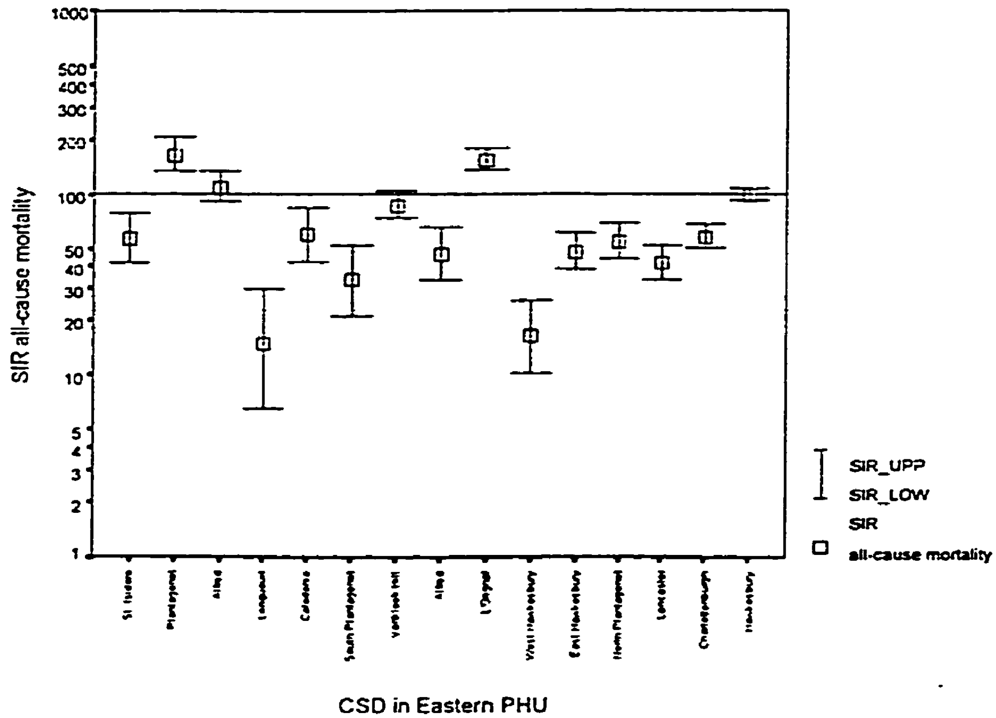


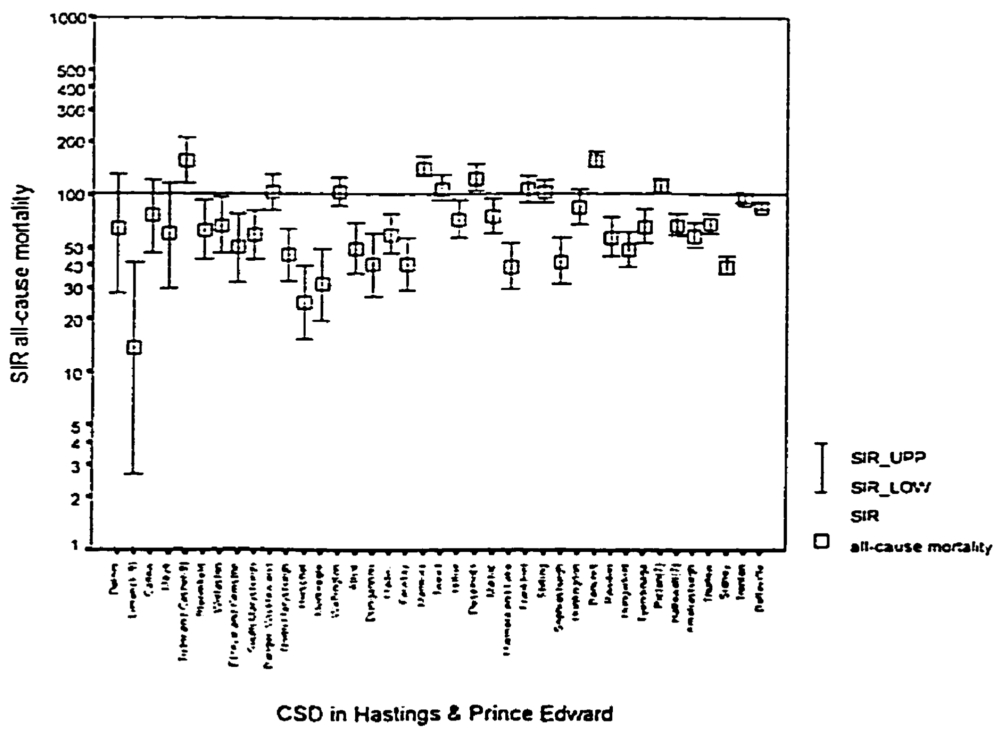
SIR low birth weight
1000
500
400
300
200
100
50
40
30
20
10
5
4
3
2
1
SIR_UPP
SIR_LOW
SIR
low birth weight
CSD in Ottawa-Carleton

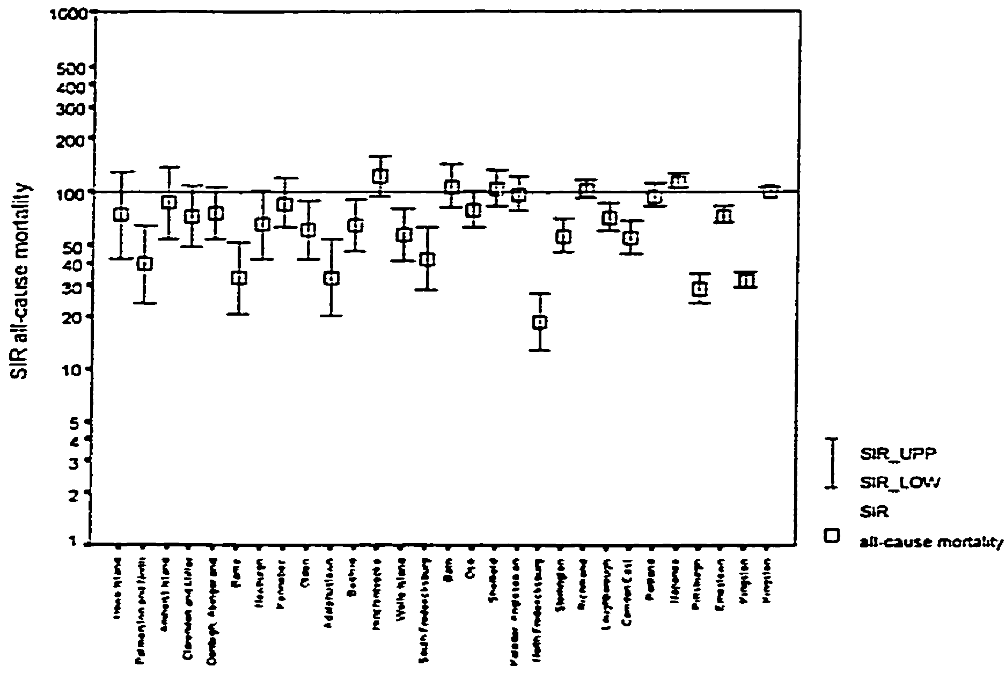


SIR low birth weight
1000
500
400
300
200
100
50
40
30
20
10
5
4
3
2
1
SIR_UPP
SIR_LOW
SIR
low birth weight
CSD in Renfrew

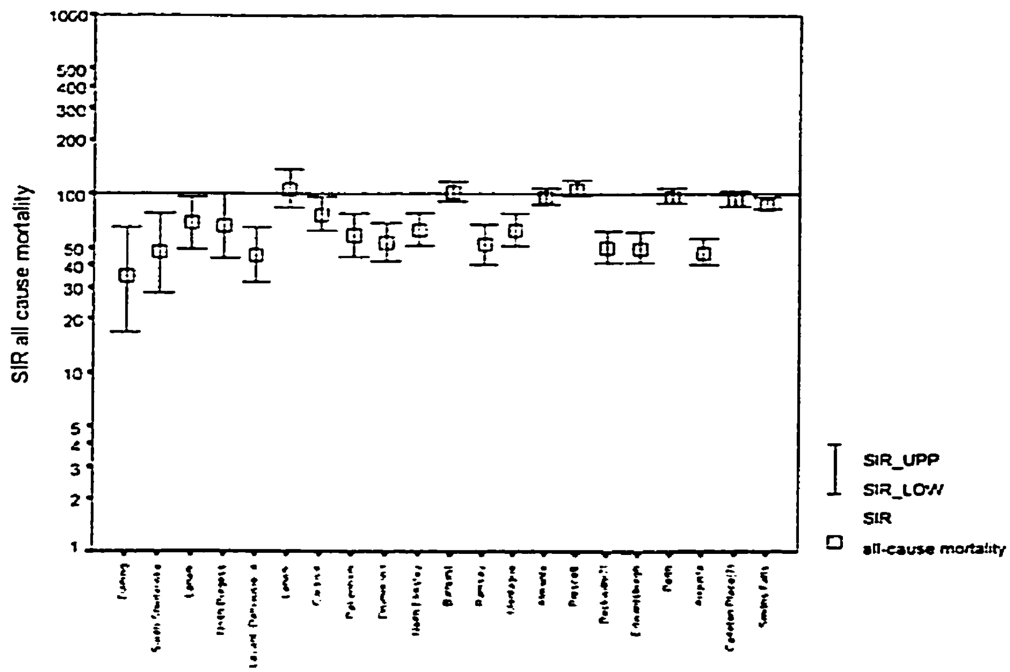
standardized mortality ratio for CSDs in each Eastern Planning Region health unit, showing 95% confidence intervals. Rates are standardized to the health unit value of the indicator.



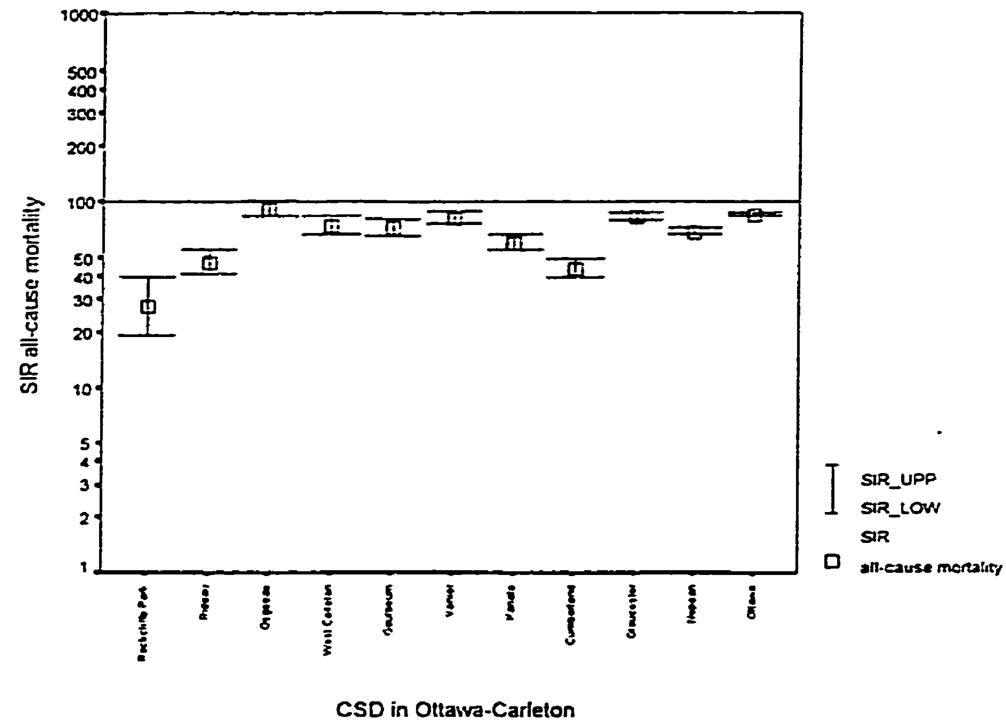




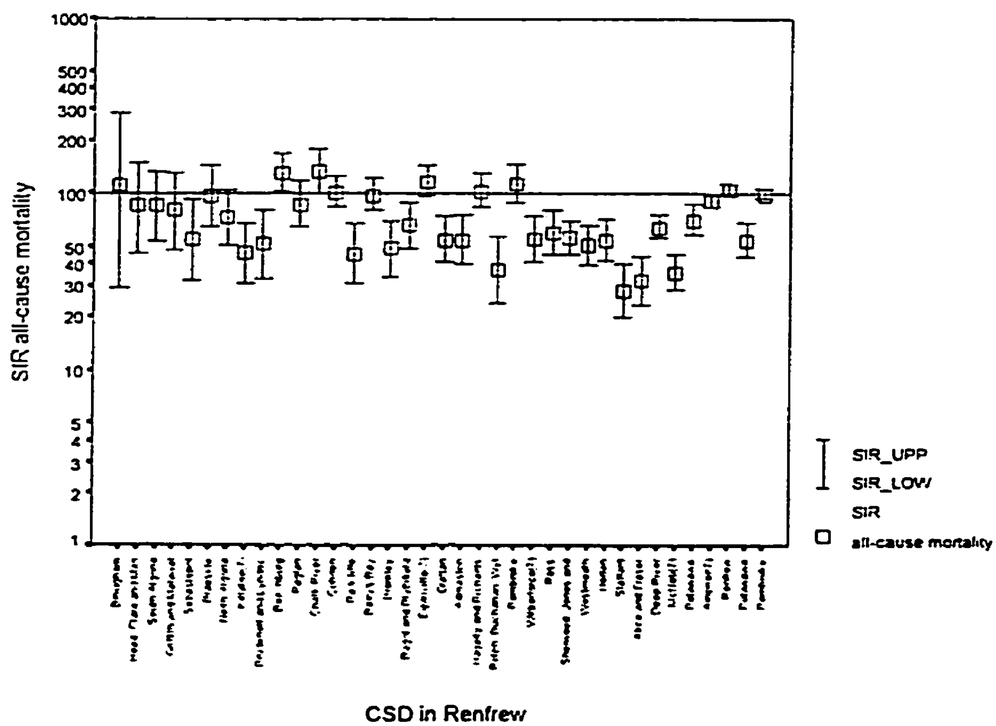
CSD in Kingston, Frontenac, Lennox & Addington



CSD in Leeds, Grenville, Lanark

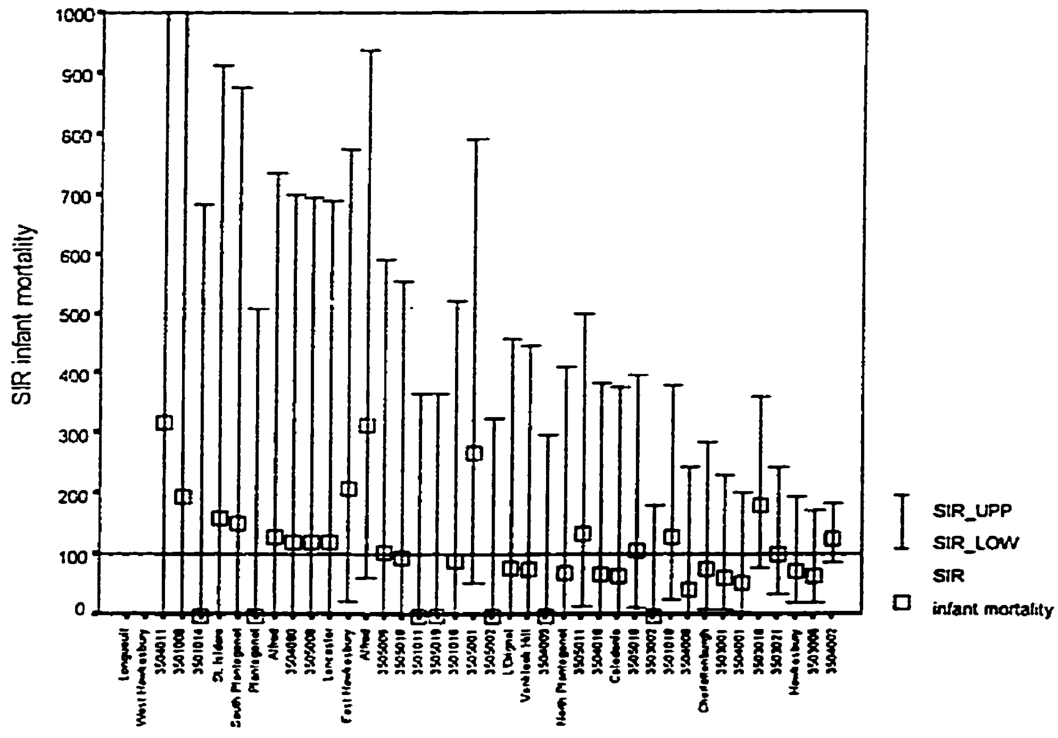


1000
500
400
300
200
100
50
40
30
20
10
5
4
3
2
1
SIR all-cause mortality
SIR_UPP
SIR_LOW
SIR
all-cause mortality
CSD in Ottawa-Carleton

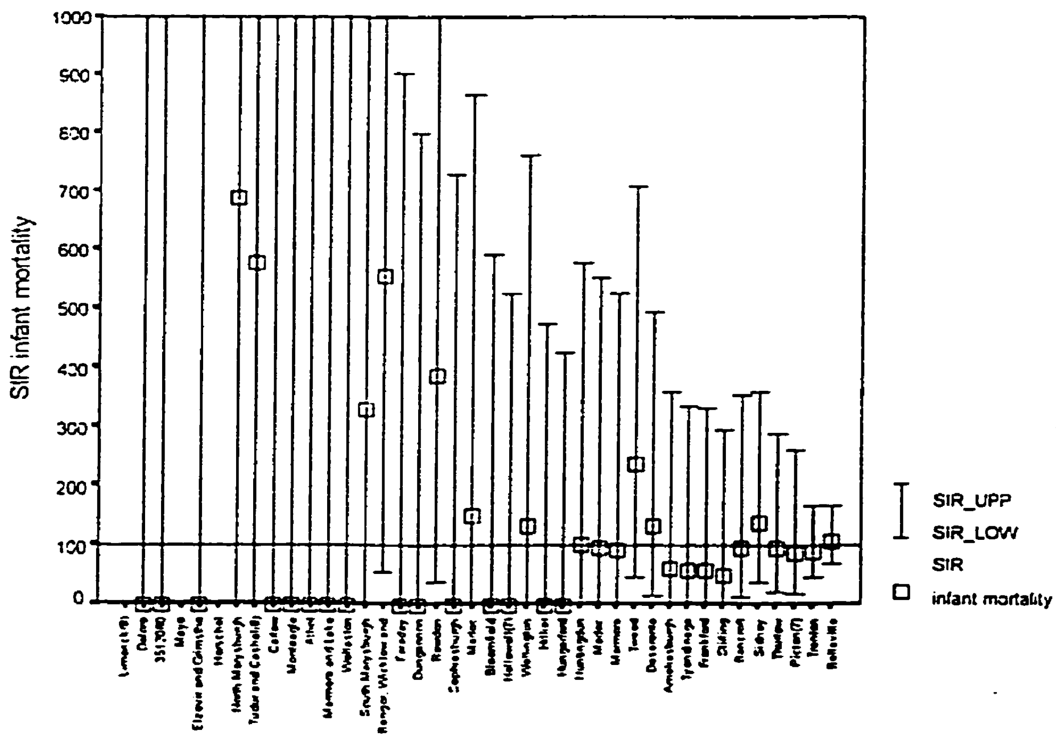


1000
500
400
300
200
100
50
40
30
20
10
5
4
3
2
1
SIR all-cause mortality
SIR_UPP
SIR_LOW
SIR
all-cause mortality
CSD in Renfrew

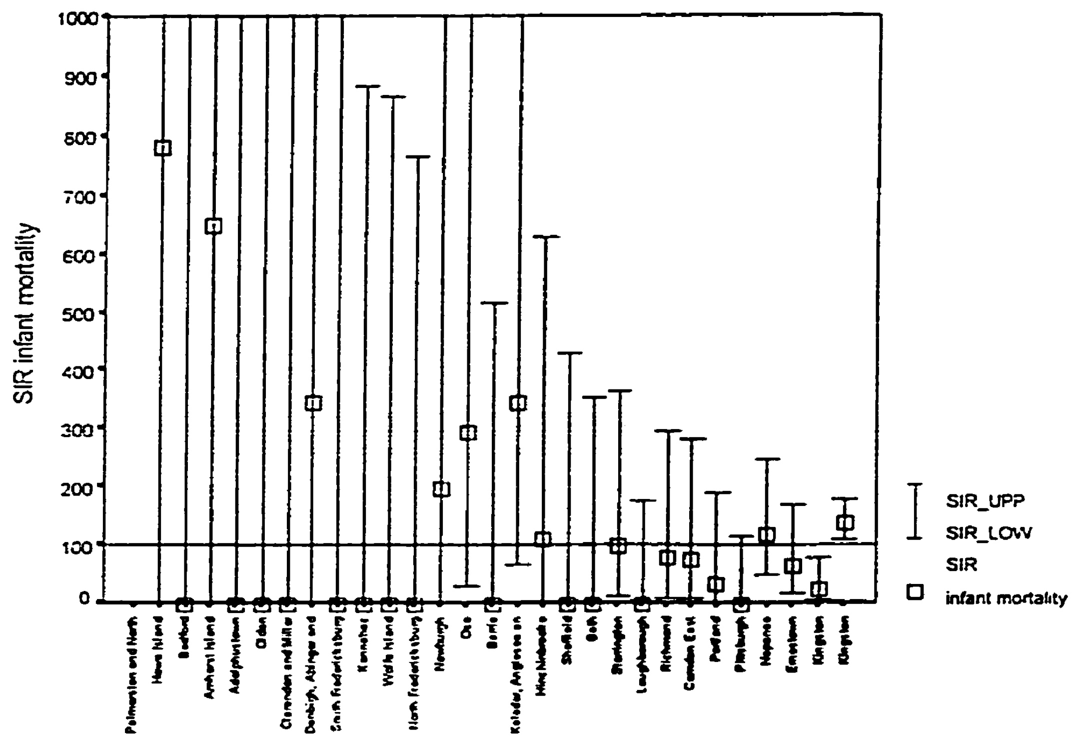
infant mortality rate: Standardized incidence ratios for CSDs in each Eastern Planning Region health unit, showing 95% confidence intervals. Rates are standardized to the health unit value of the indicator.



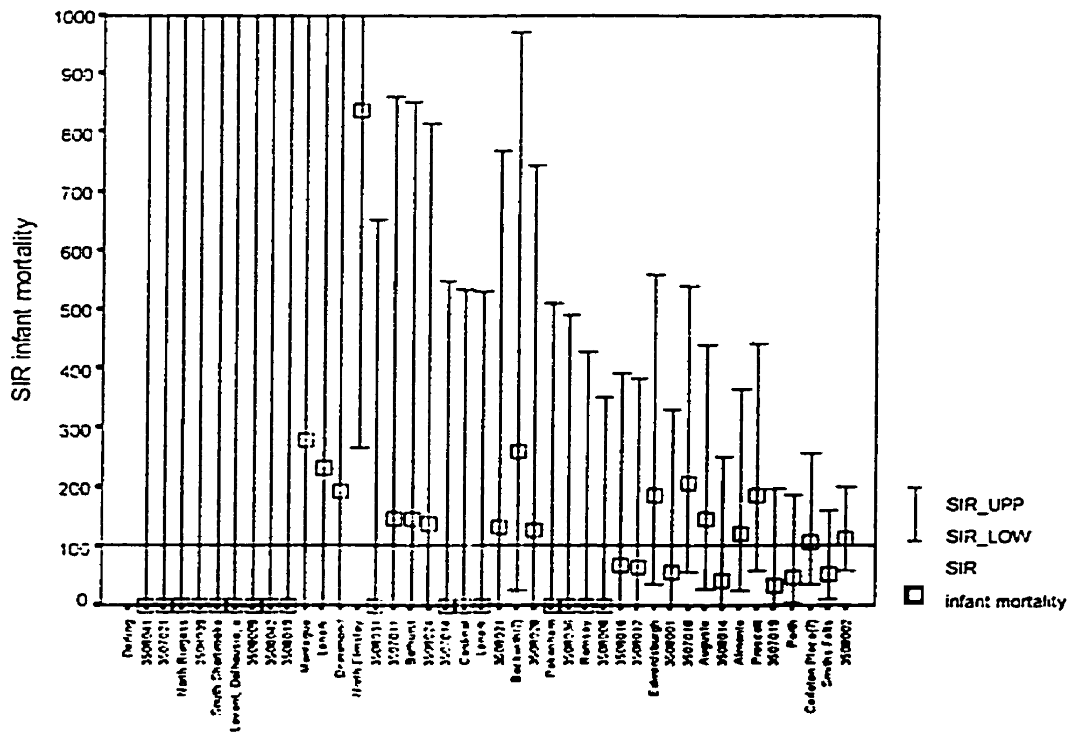
CSD in Eastern PHU



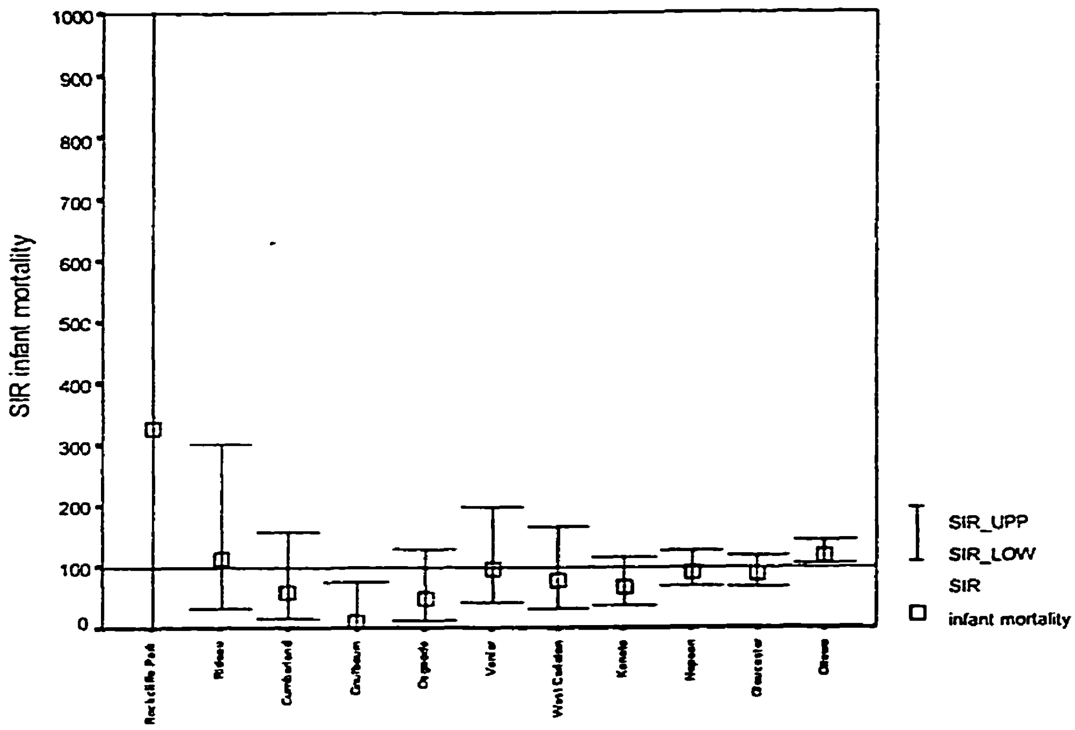
CSD in Hastings & Prince Edward



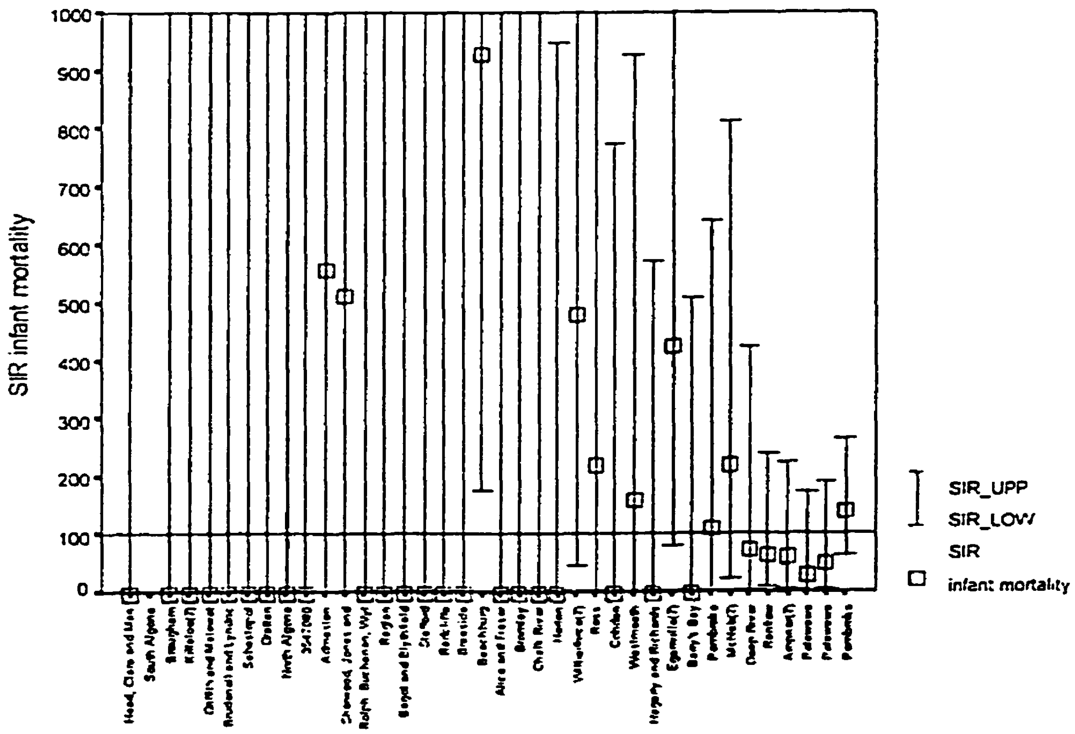
CSD in Kingston, Frontenac, Lennox & Addington



CSD in Leeds, Grenville, Lanark

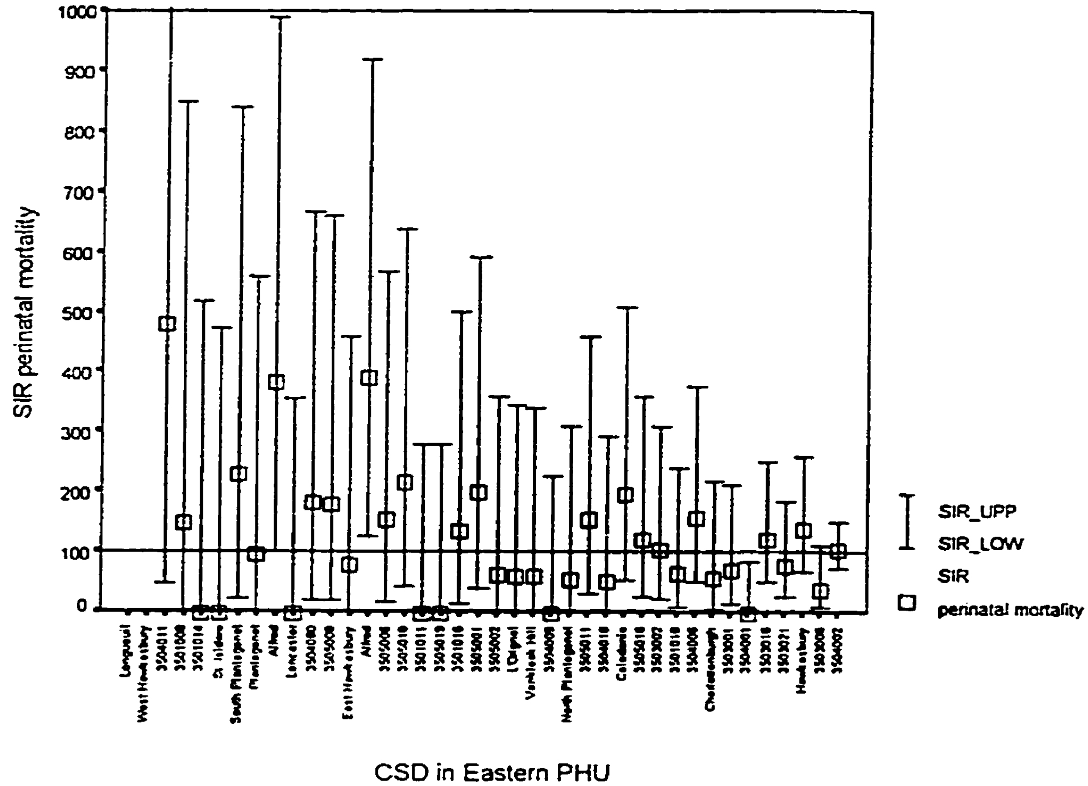


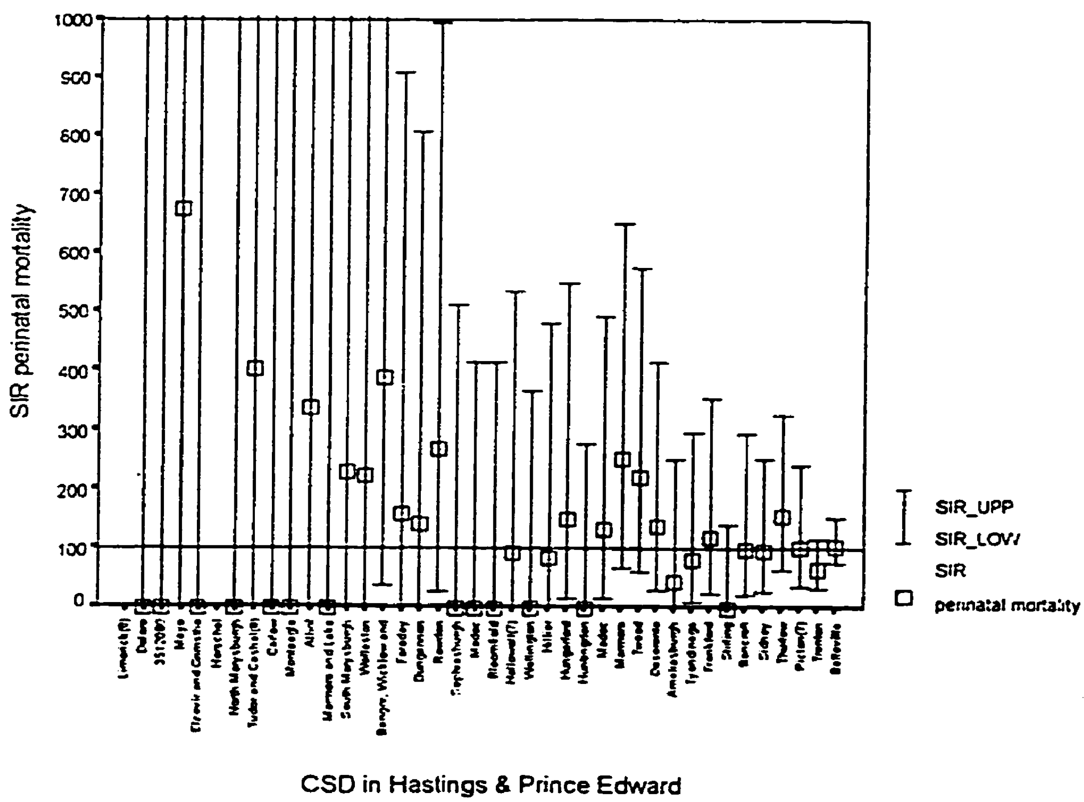
CSD in Ottawa-Carleton

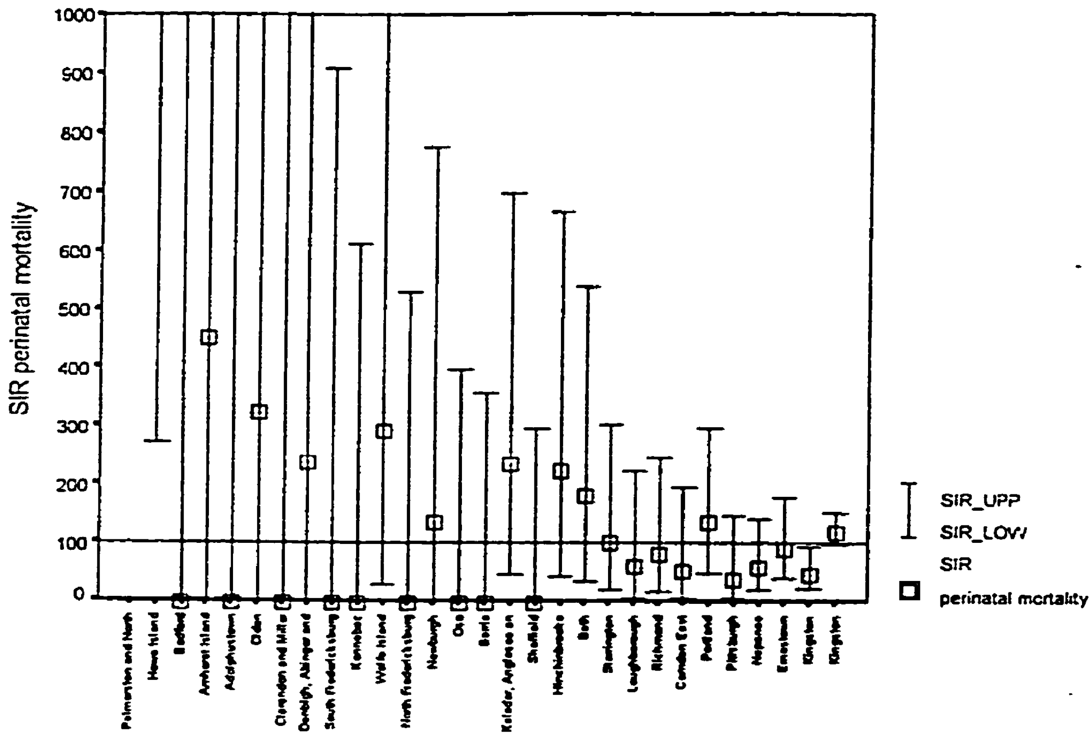


CSD in Renfrew

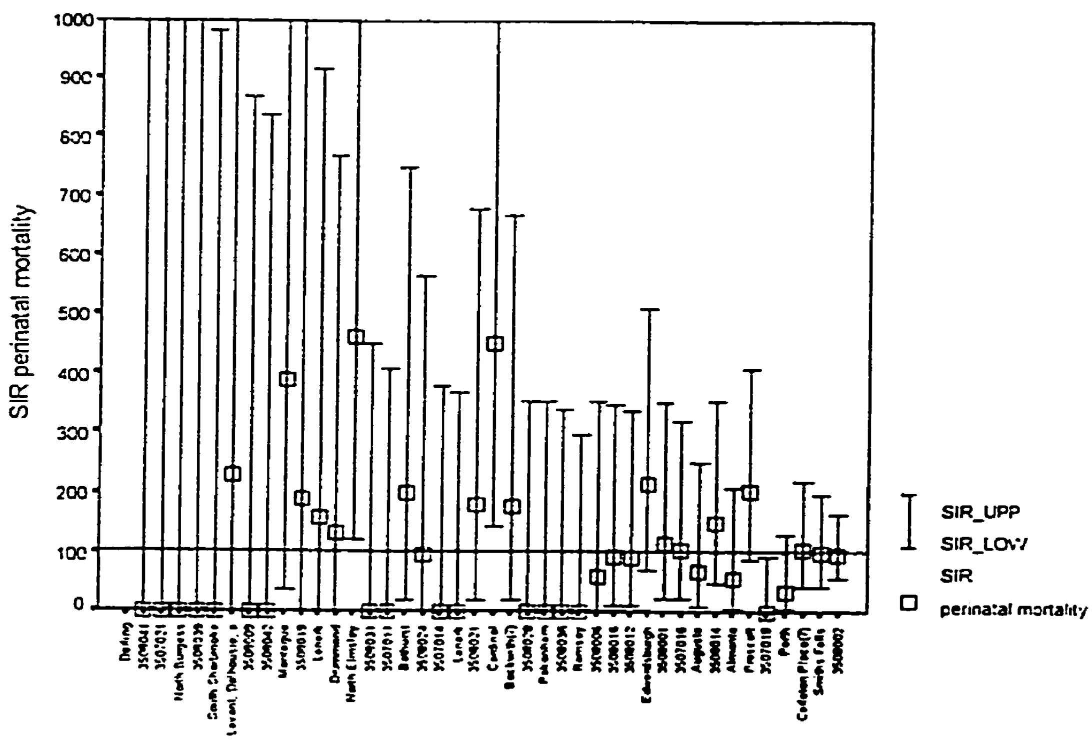
perinatal mortality: Standardized incidence ratios for CSDs in each Eastern Planning Region health unit, showing 95% confidence intervals. Rates are standardized to the health unit value of the indicator.



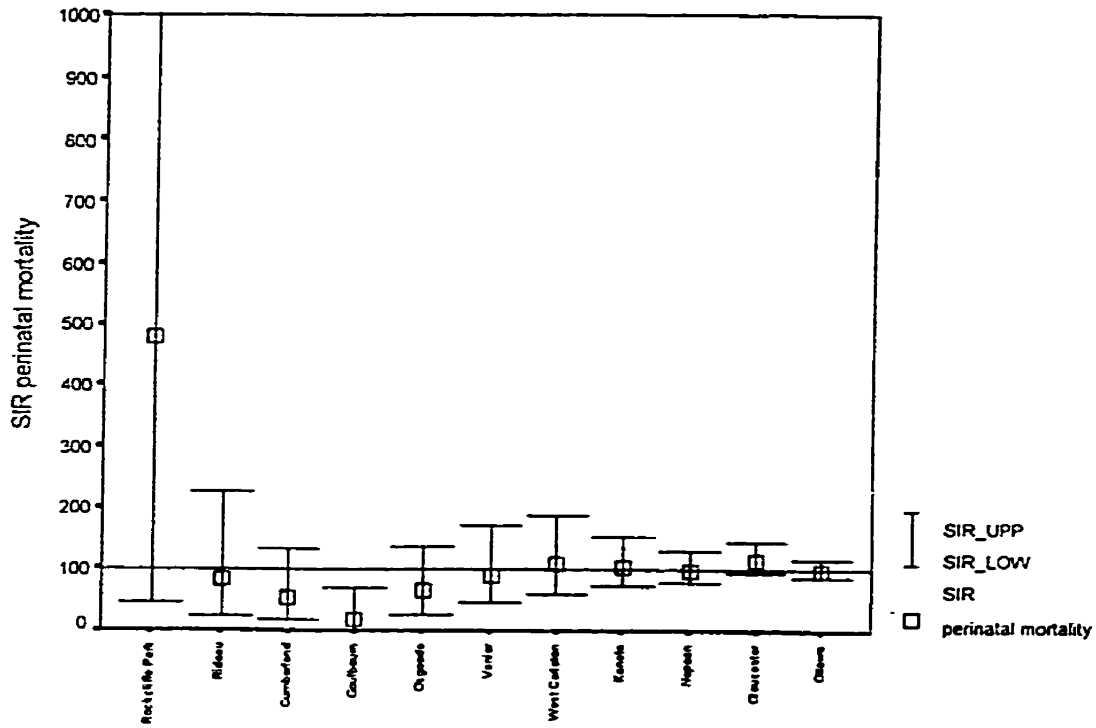




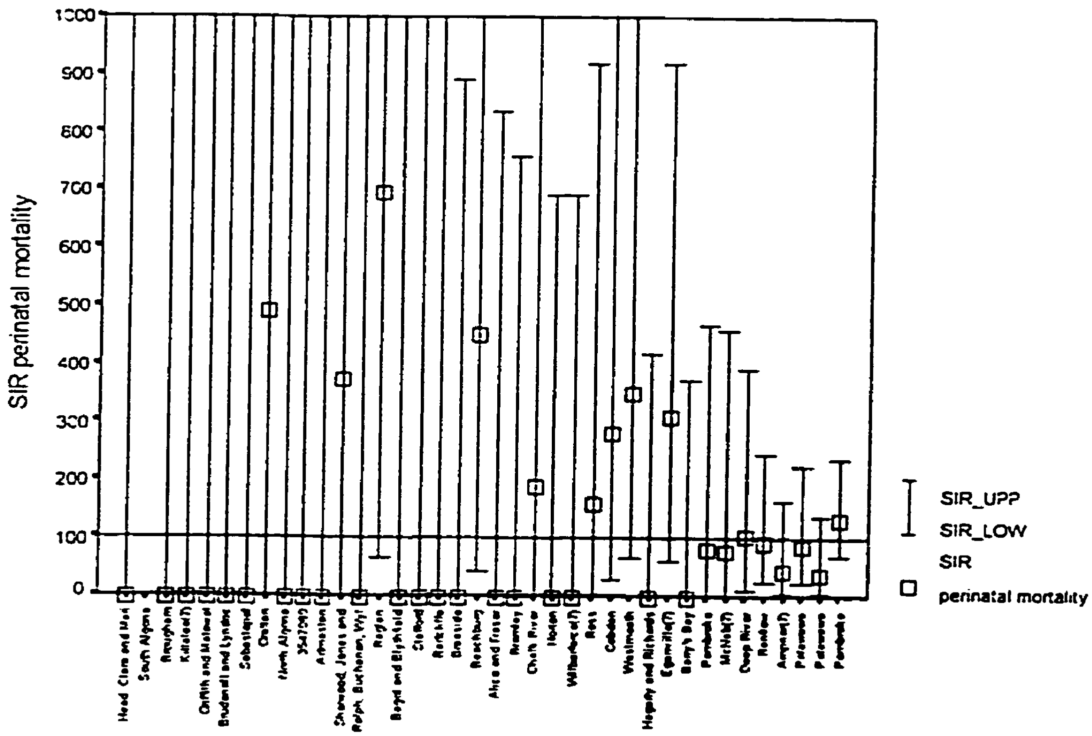
CSD in Kingston, Frontenac, Lennox & Addington



CSD in Leeds, Grenville, Lanark

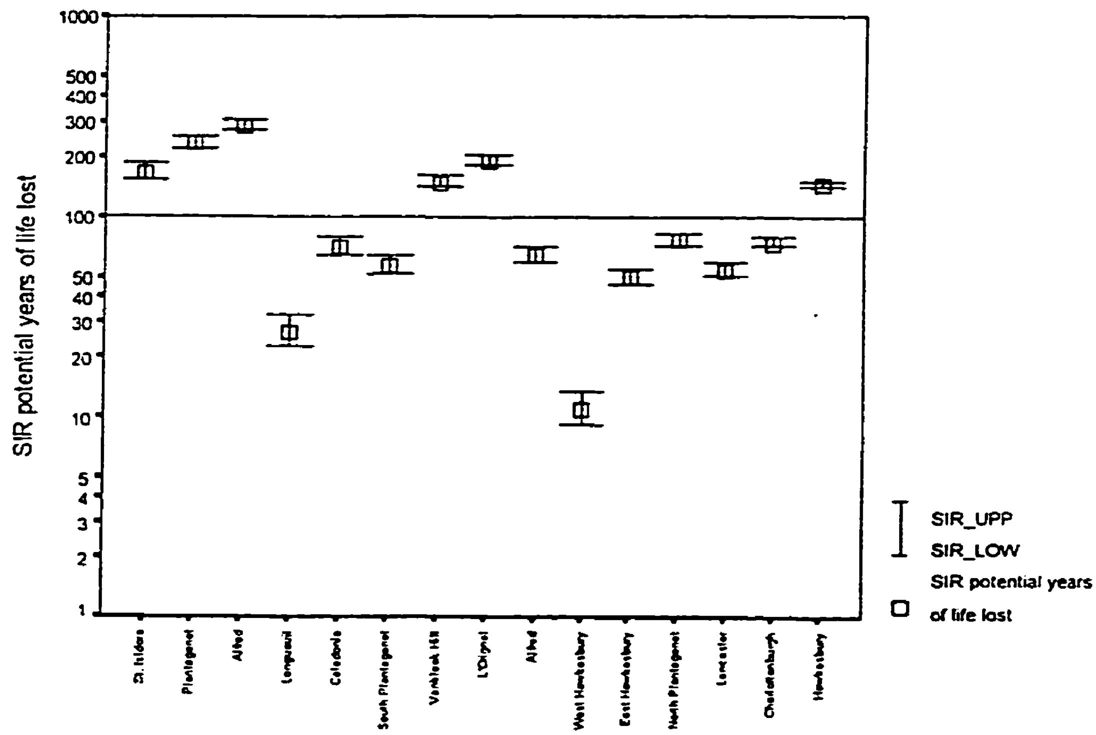


CSD in Ottawa-Carleton

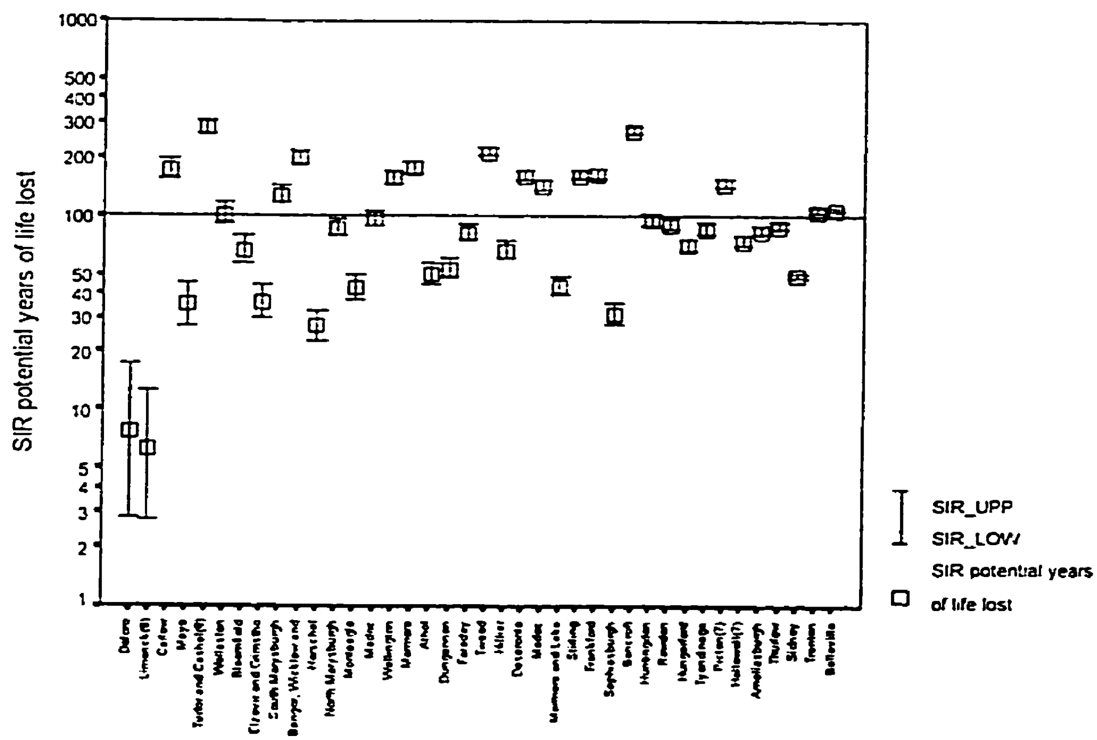


CSD in Renfrew

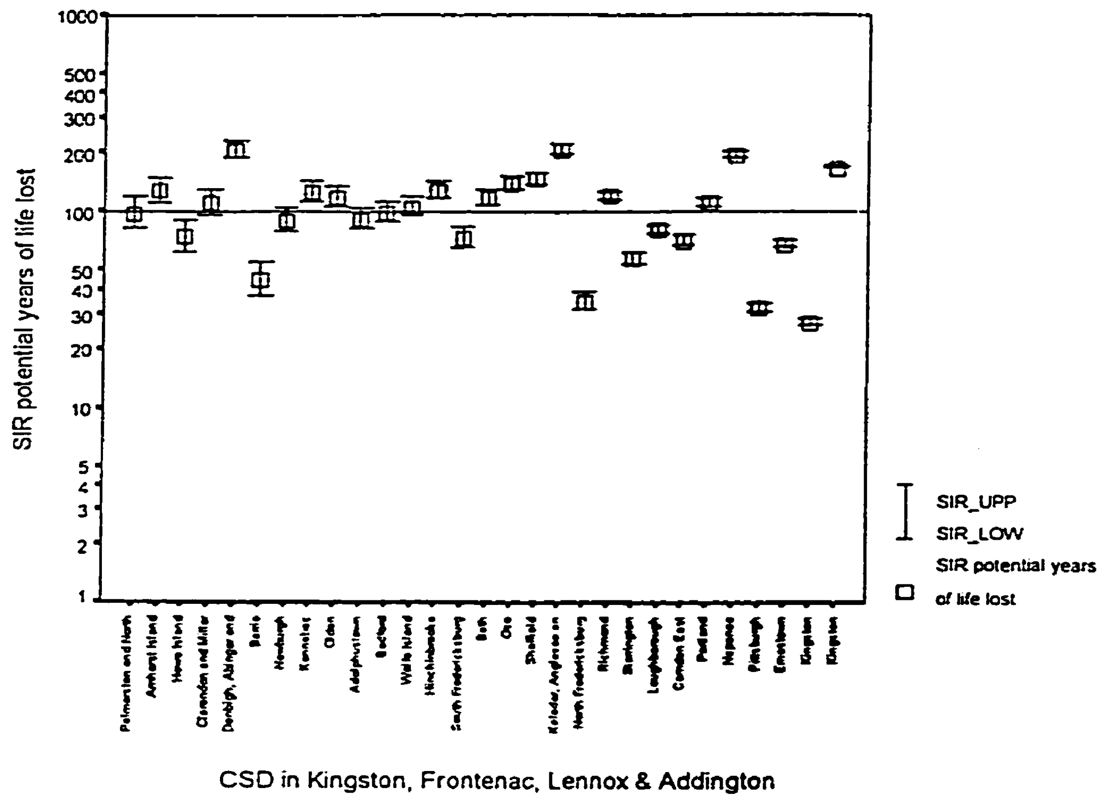
potential years of life lost: Standardized incidence ratios for CSDs in each Eastern Planning Region health unit, showing 95% confidence intervals. Rates are standardized to the health unit value of the indicator.

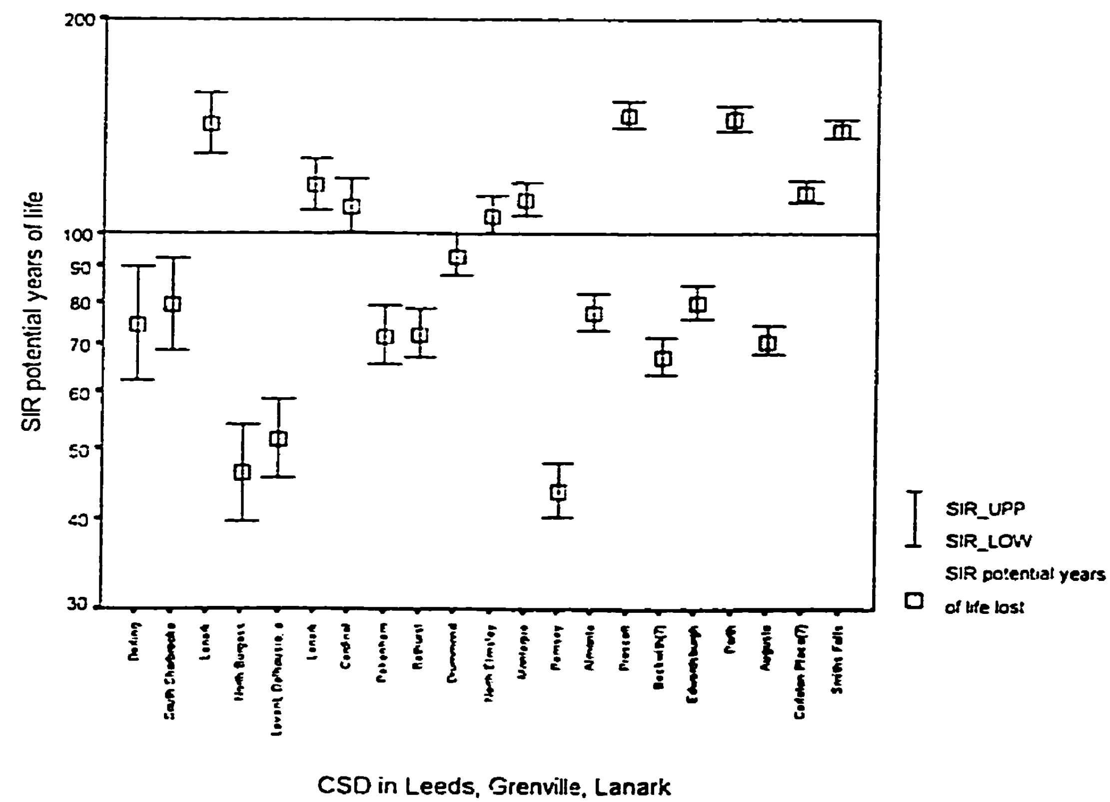


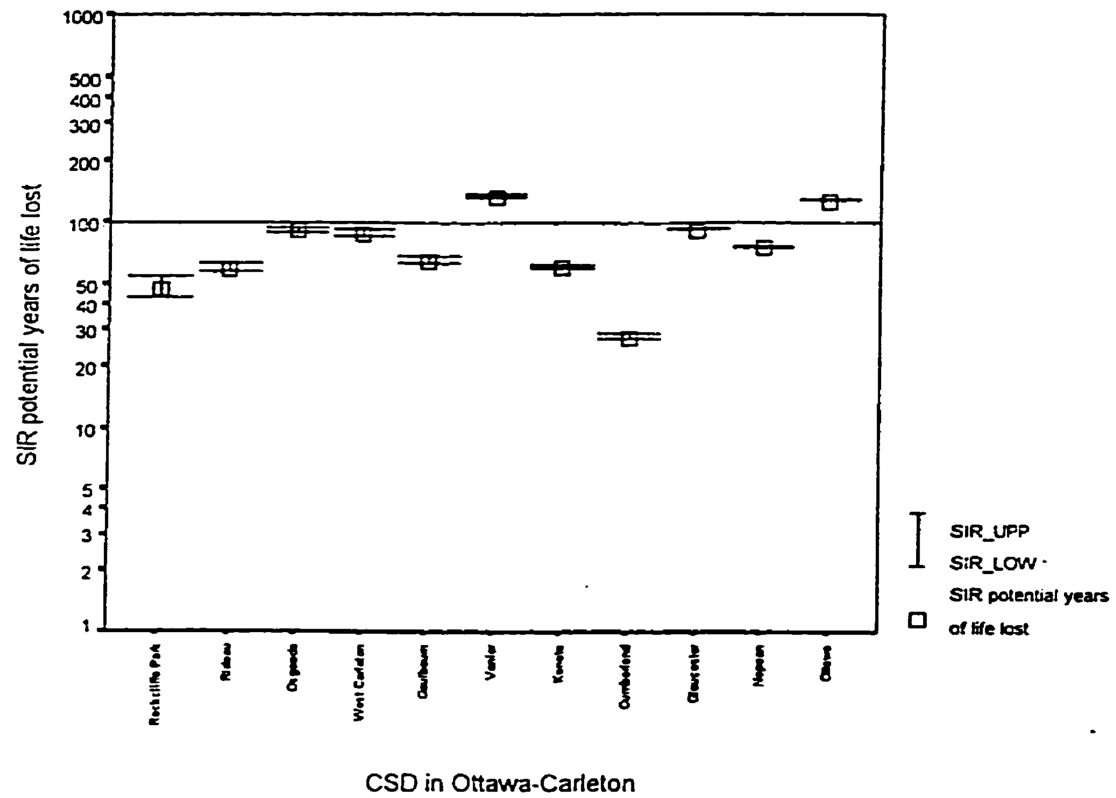
CSD in Eastern PHU

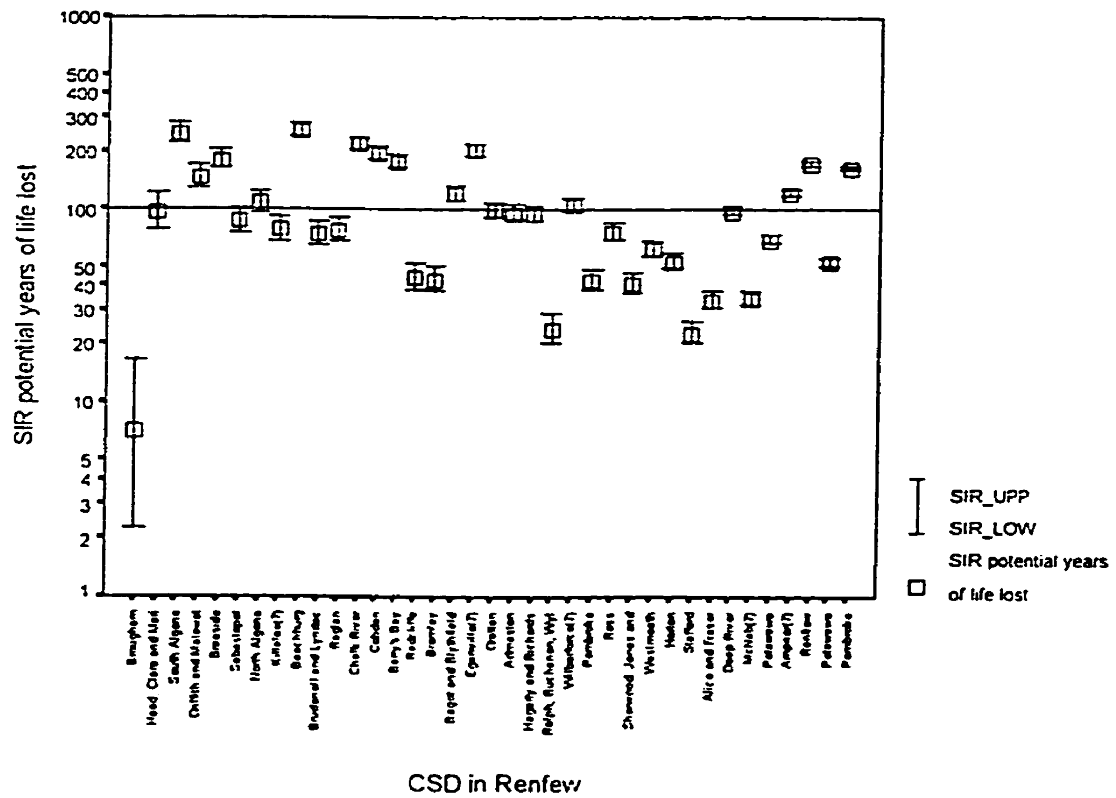


CSD in Hastings & Prince Edward

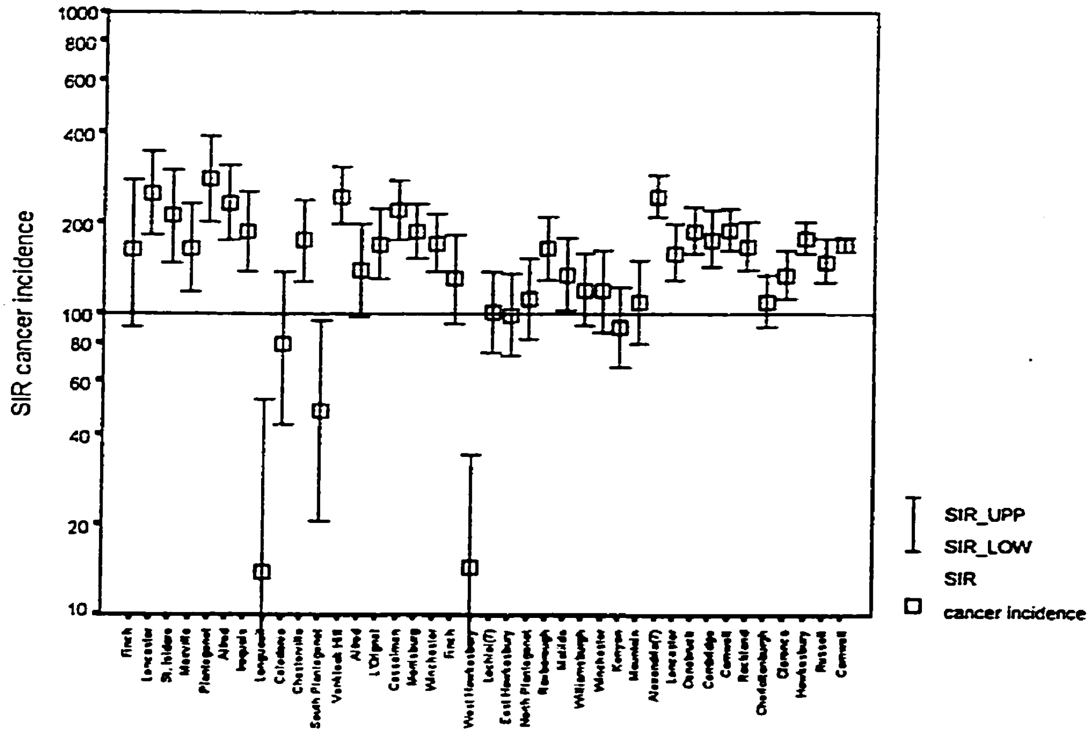

SIR potential years of life lost
1000
500
400
300
200
100
50
40
30
20
10
5
4
3
2
1
SIR_UPP
SIR_LOW
SIR potential years
of life lost
CSD in Kingston, Frontenac, Lennox & Addington


SIR potential years of life
200
100
90
80
70
60
50
40
30
SIR_UPP
SIR_LOW
SIR potential years
of life lost
CSD in Leeds, Grenville, Lanark

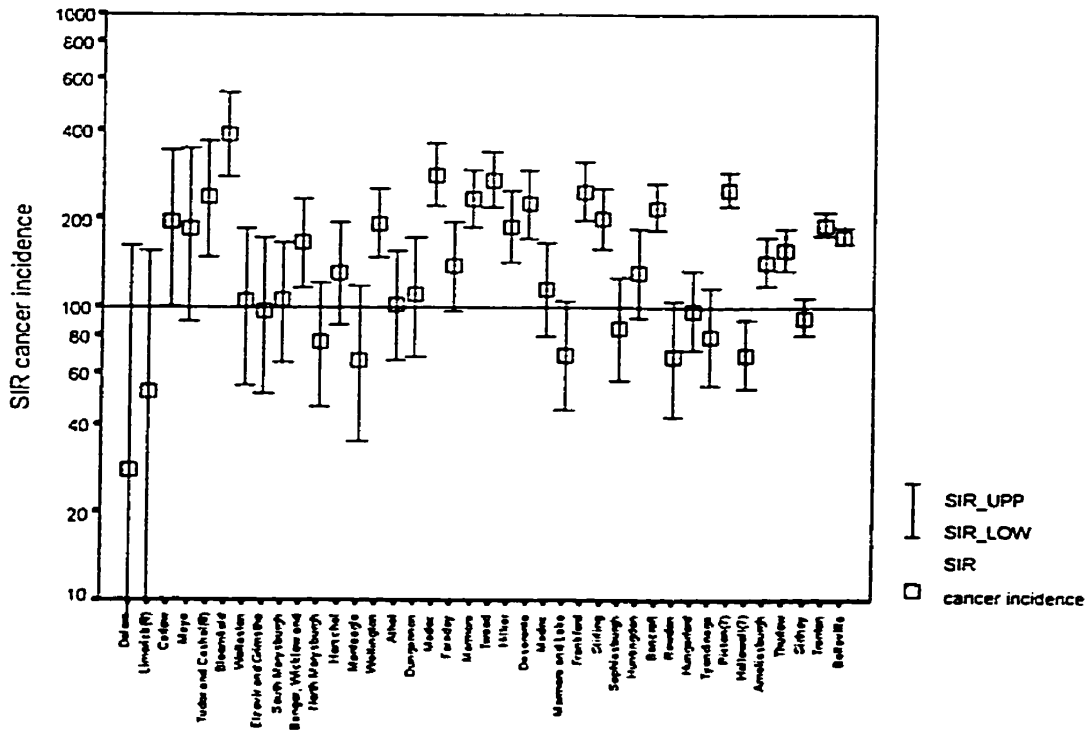

SIR potential years of life lost
1000
500
400
300
200
100
50
40
30
20
10
5
4
3
2
1
Rockcliffe Park
Rideau
Osgoode
West Carleton
Goulbourn
Vanier
Kanata
Cumberland
Gloucester
Nepean
Ottawa
CSD in Ottawa-Carleton
SIR_UPP
SIR_LOW
SIR potential years of life lost


SIR potential years of life lost
1000
500
400
300
200
100
50
40
30
20
10
5
4
3
2
1
CSD in Renfew
SIR_UPP
SIR_LOW
SIR potential years of life lost

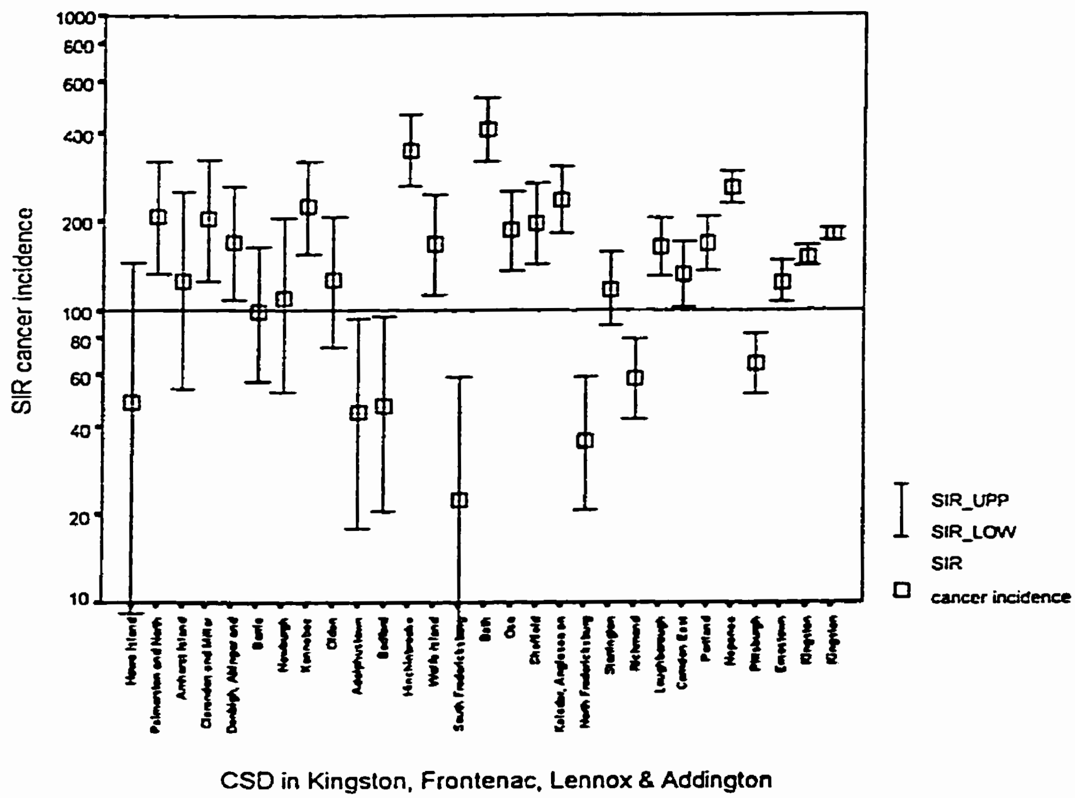
cancer incidence rate: Standardized incidence rates for CSDs in each Eastern Planning Region health unit, showing 95% confidence intervals. Rates are standardized to the health unit value of the indicator.

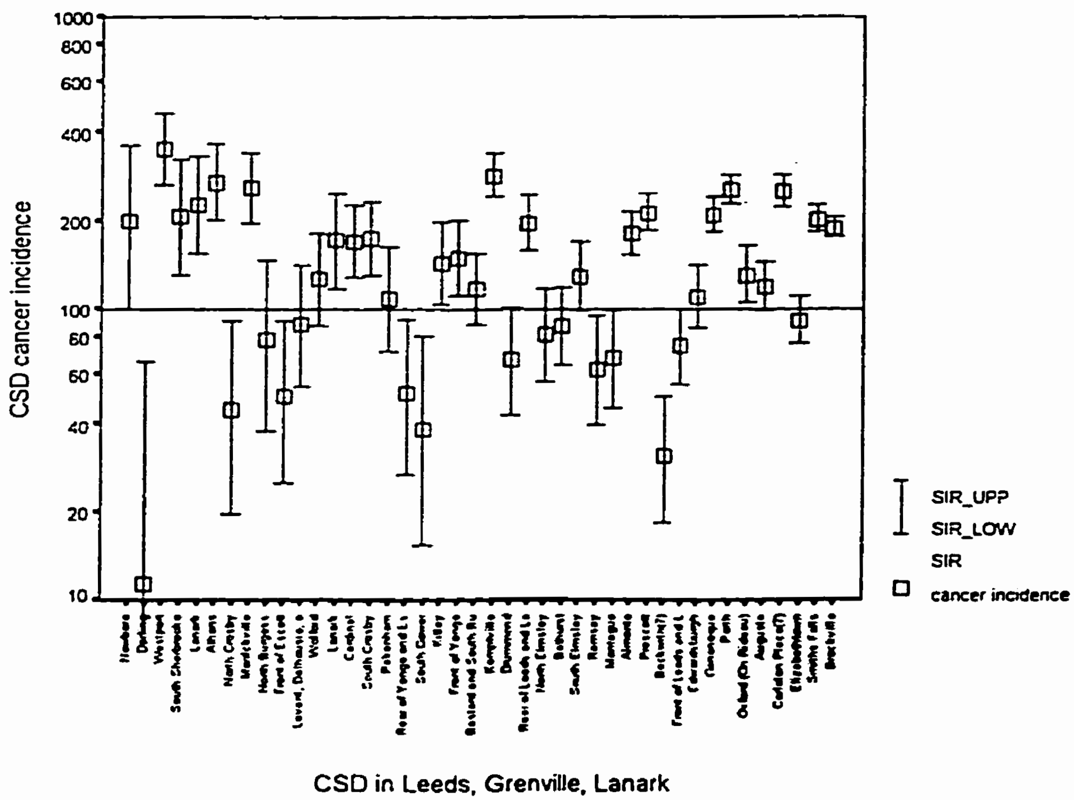


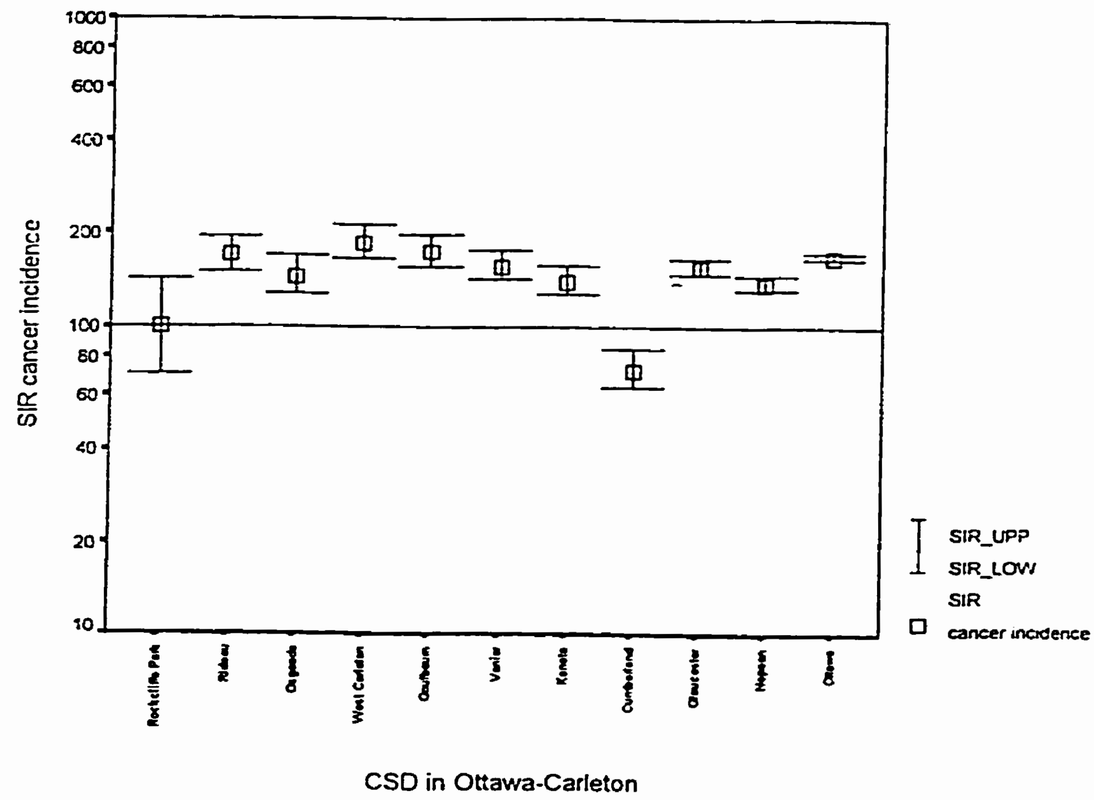
CSD in Eastern PHU

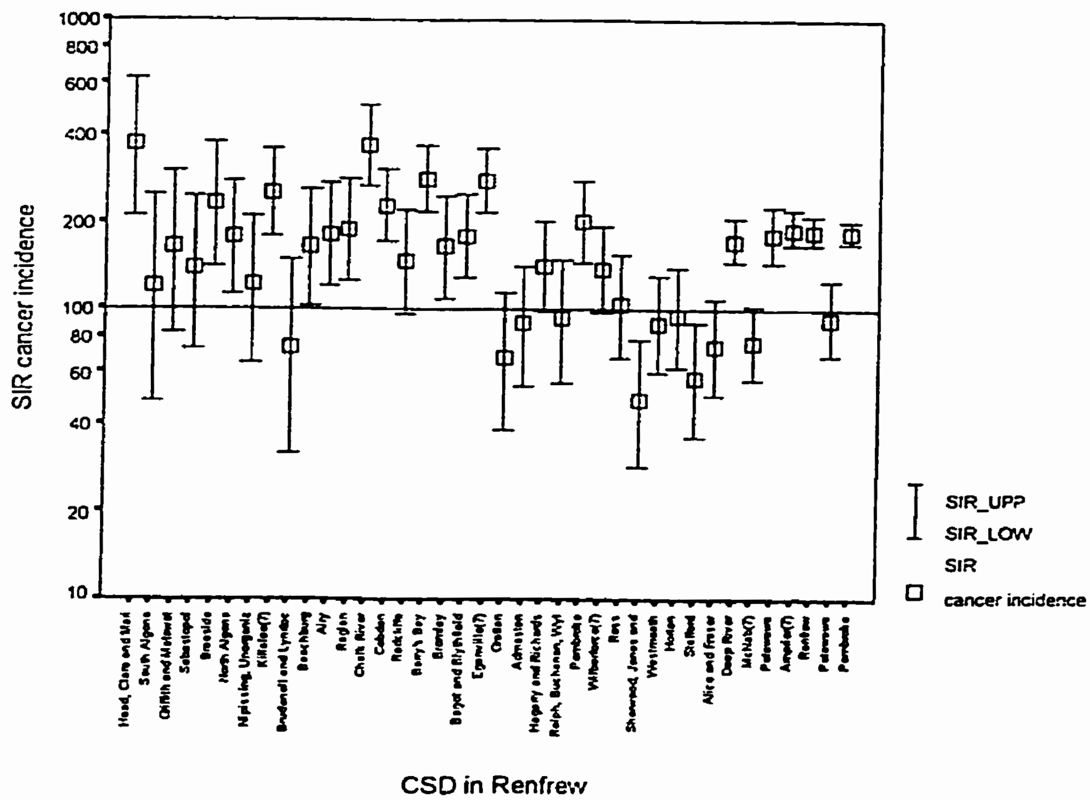


CSD in Hastings & Prince Edward


SIR cancer incidence
1000
800
600
400
200
100
80
60
40
20
10
SIR_UPP
SIR_LOW
SIR
cancer incidence
CSD in Kingston, Frontenac, Lennox & Addington


CSD cancer incidence
1000
800
600
400
200
100
80
60
40
20
10
SIR_UPP
SIR_LOW
SIR
cancer incidence
CSD in Leeds, Grenville, Lanark


1000
800
600
400
200
100
80
60
40
20
10
SIR cancer incidence
Rockcliffe Park
Rideau
Osgoode
West Carleton
Goulbourn
Vanier
Kanata
Cumberland
Gloucester
Nepean
Ottawa
SIR_UPP
SIR_LOW
SIR
cancer incidence
CSD in Ottawa-Carleton

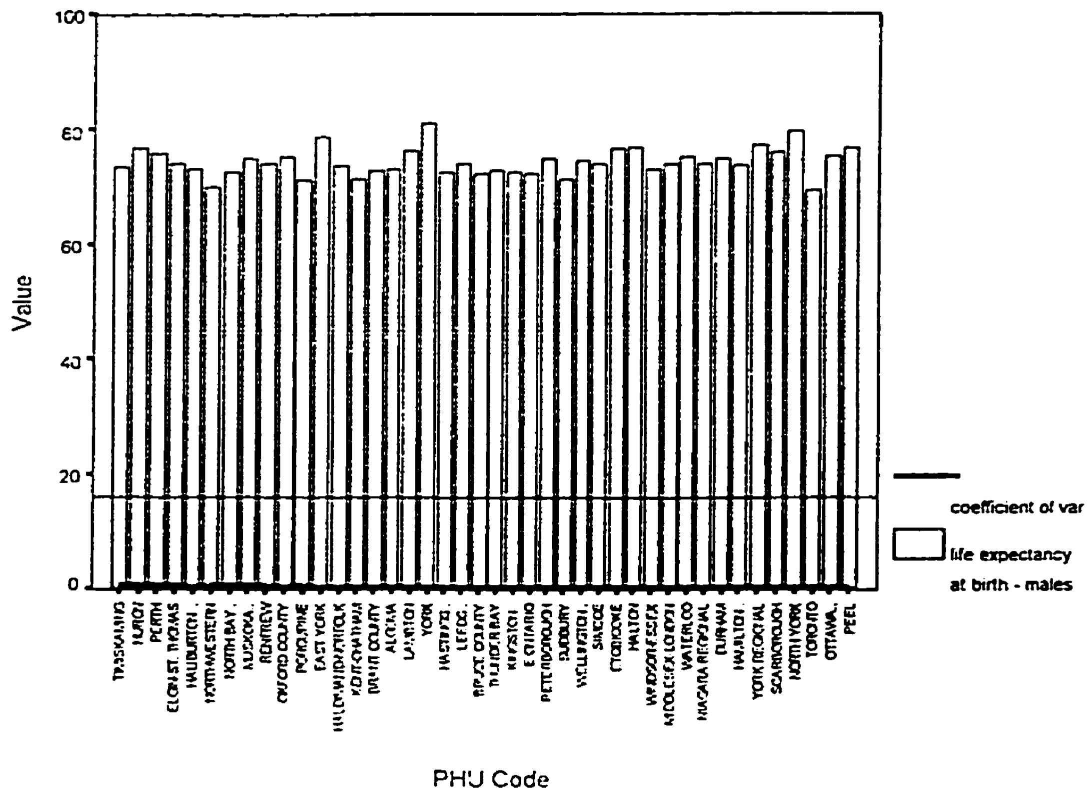

1000
800
600
400
200
100
80
60
40
20
10
SIR cancer incidence
SIR_UPP
SIR_LOW
SIR
cancer incidence
CSD in Renfrew

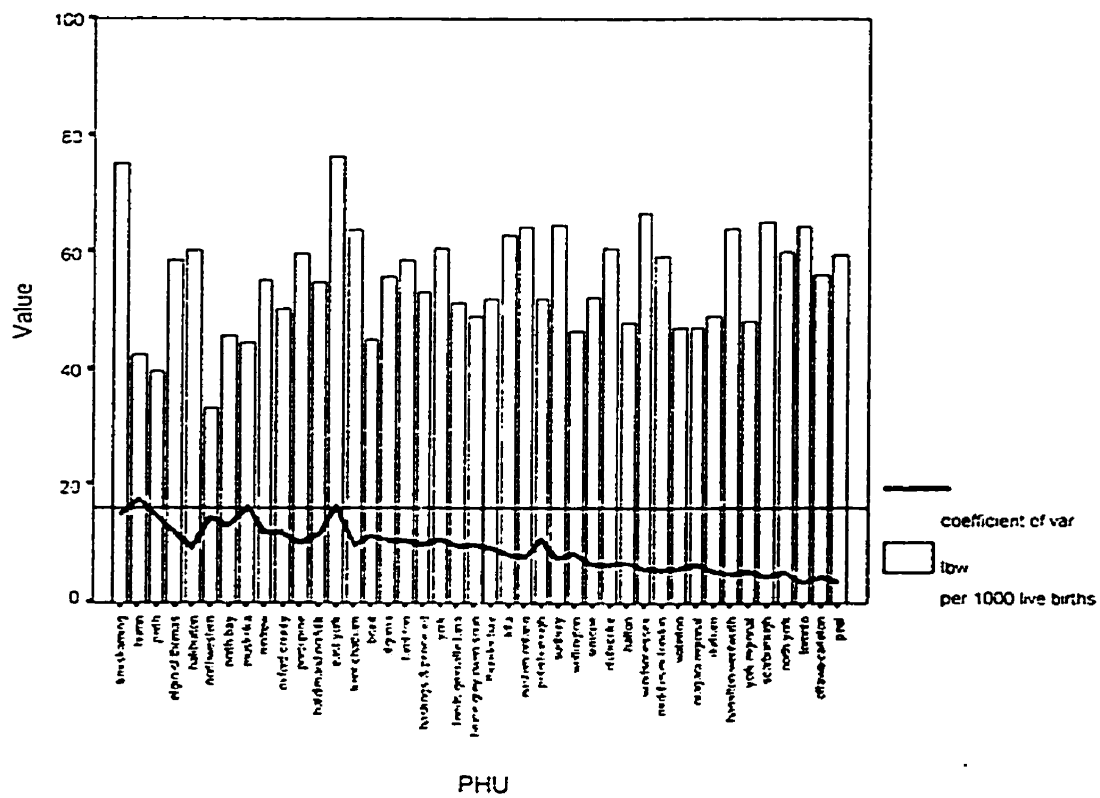
Appendix 3

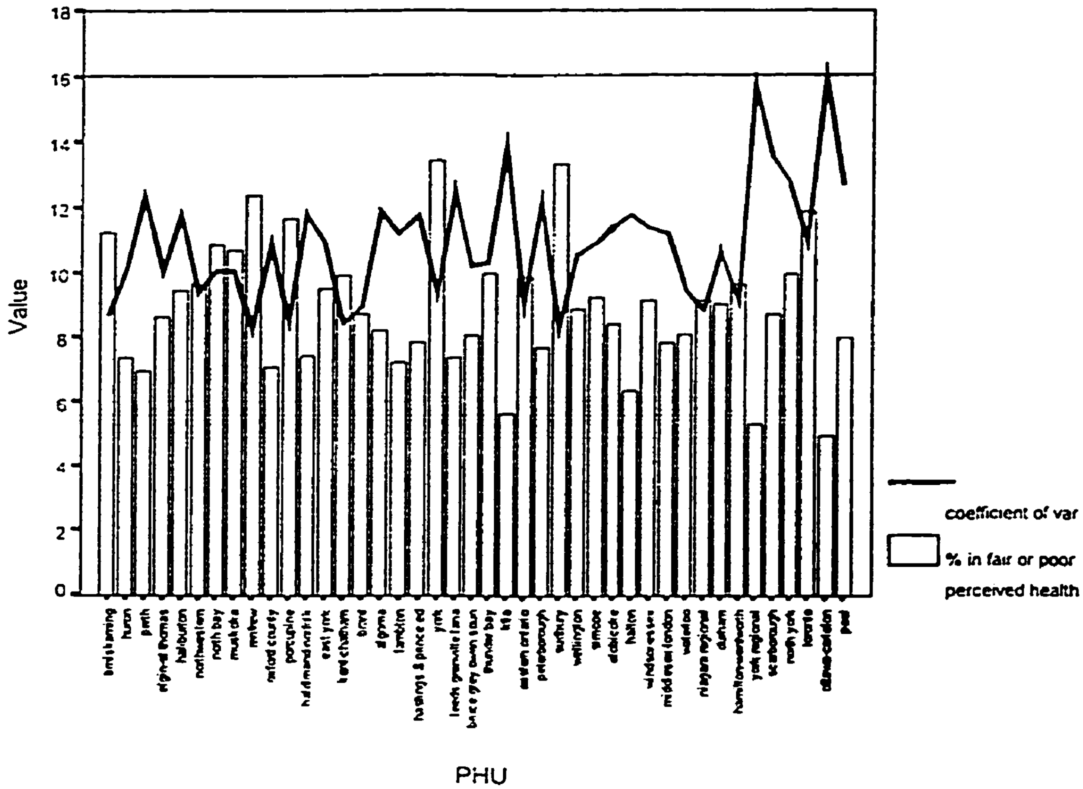
1991 values for Ontario Community Health Profile health status indicators by health unit

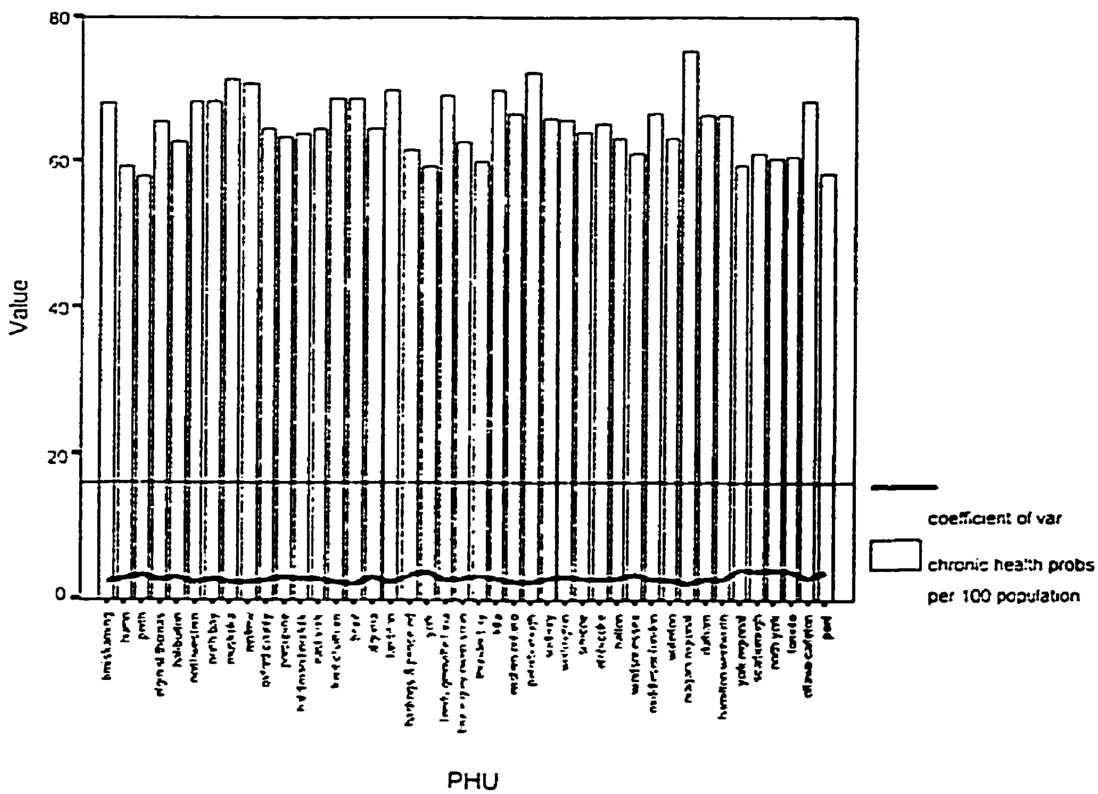
Each graph presents the 1991 values for an OCHP health status indicator. Results are presented by health unit, with corresponding coefficients of variation. The reference line indicates cut-off for stable estimation (a CV of 16.5%). Health units are listed in order of increasing population.

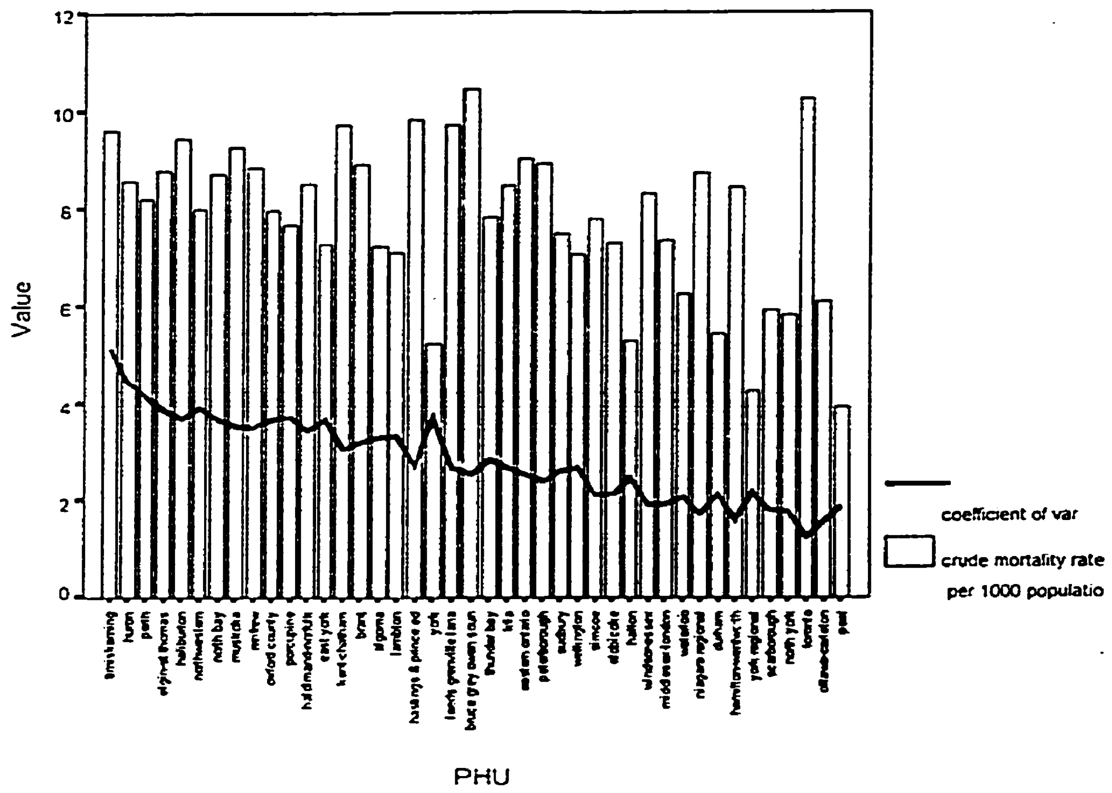
health status indicators: Actual indicator value and corresponding coefficient of variation by health unit. Health units are listed in order of increasing population.

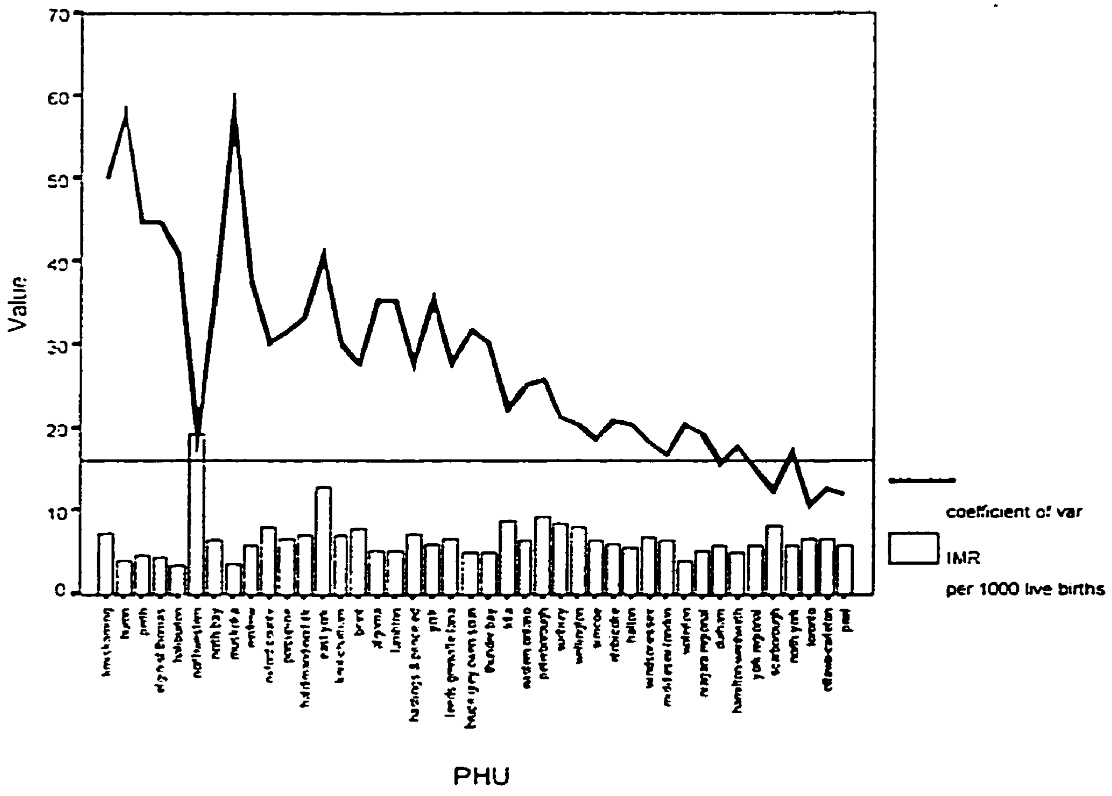


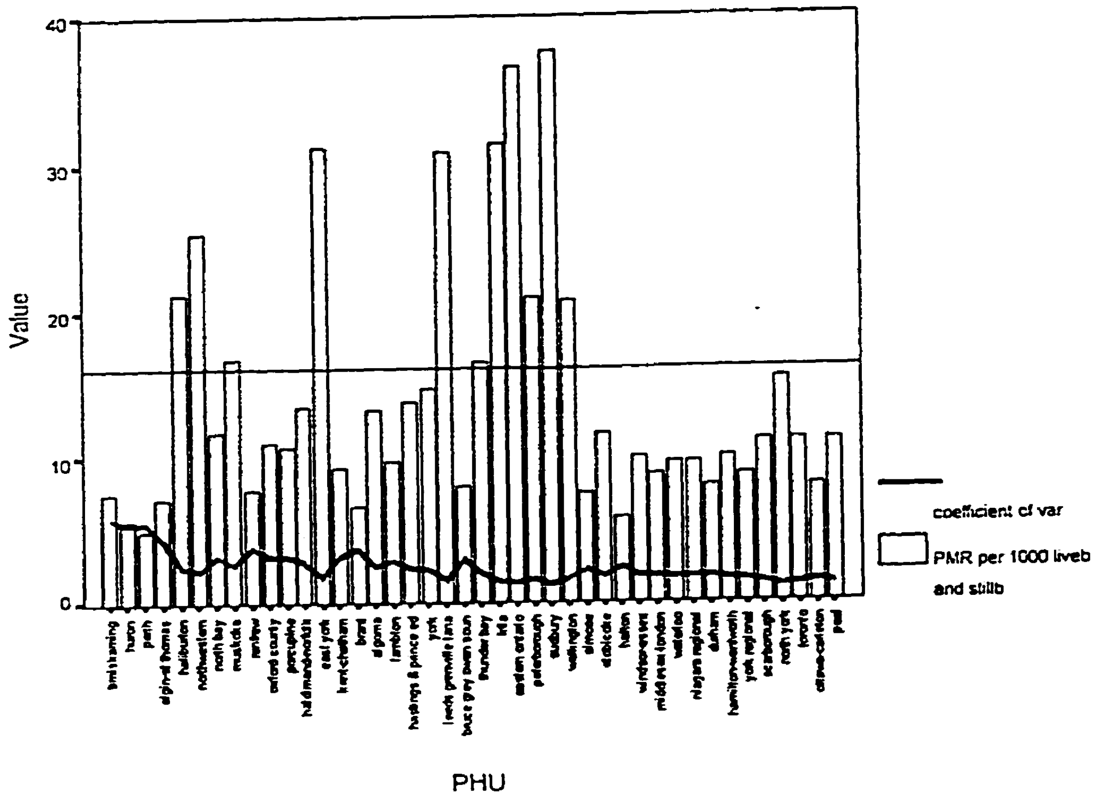


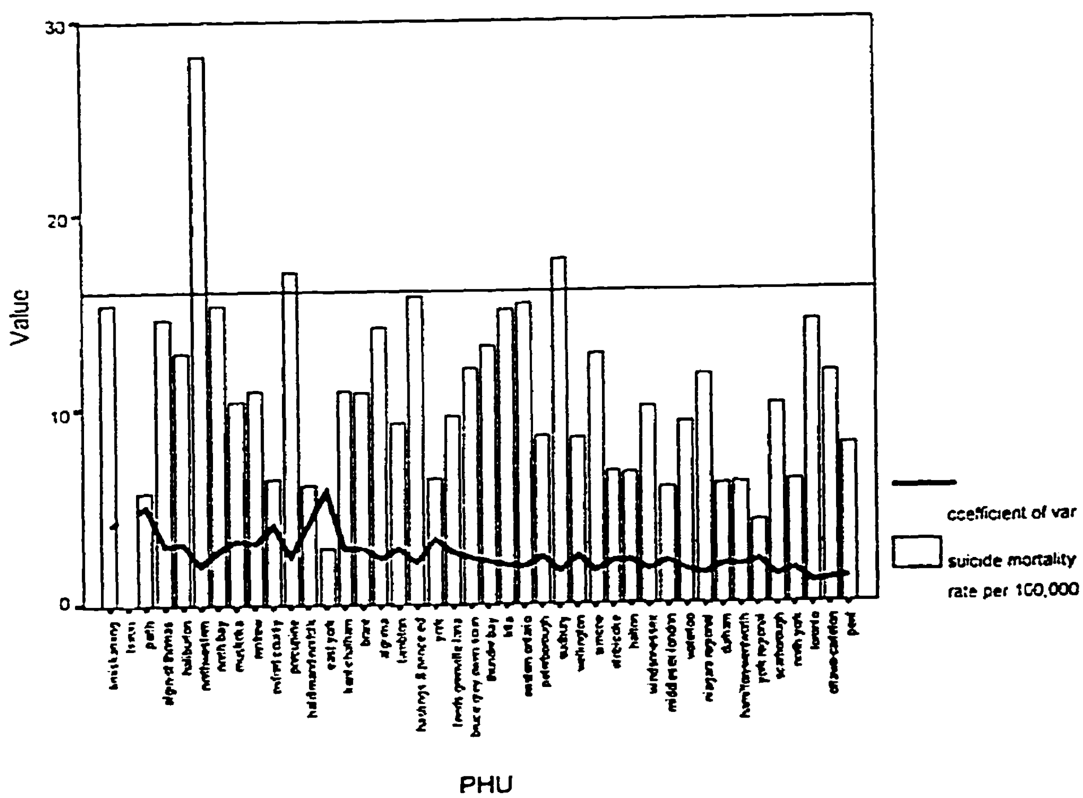

18
16
14
12
10
8
6
4
2
0
Value
coefficient of var
% in fair or poor
perceived health
PHU

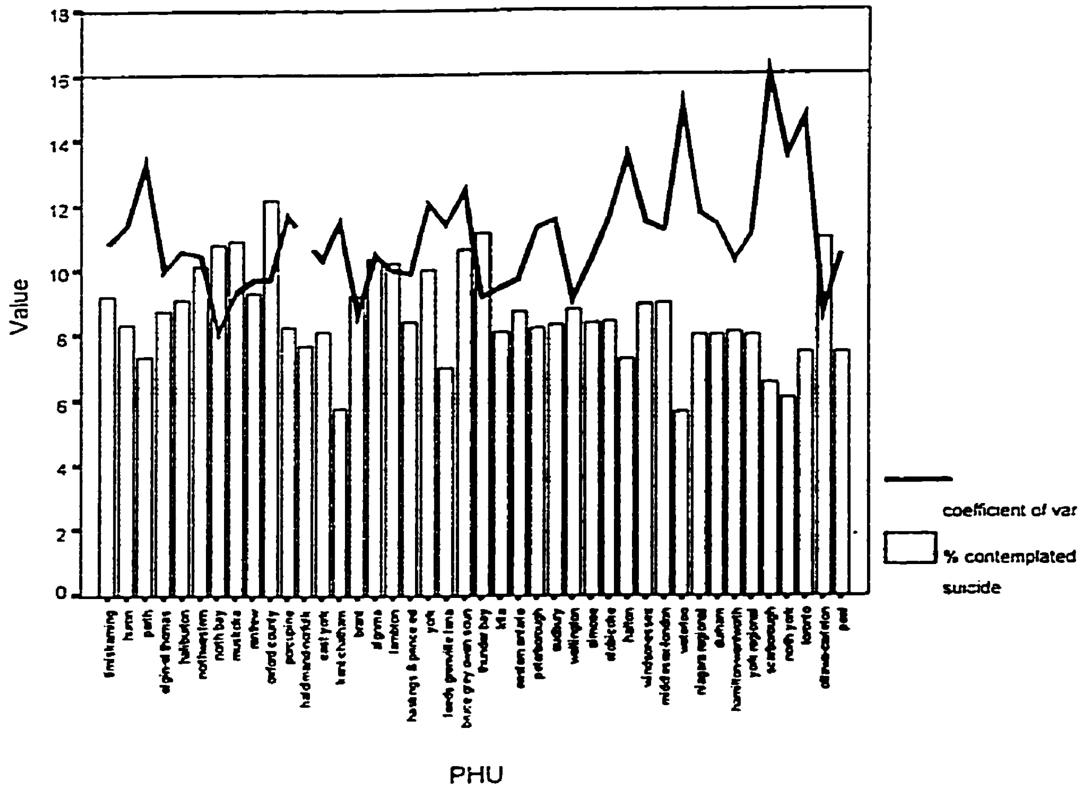

80
60
40
20
0
Value
coefficient of var
chronic health probs
per 100 population
PHU

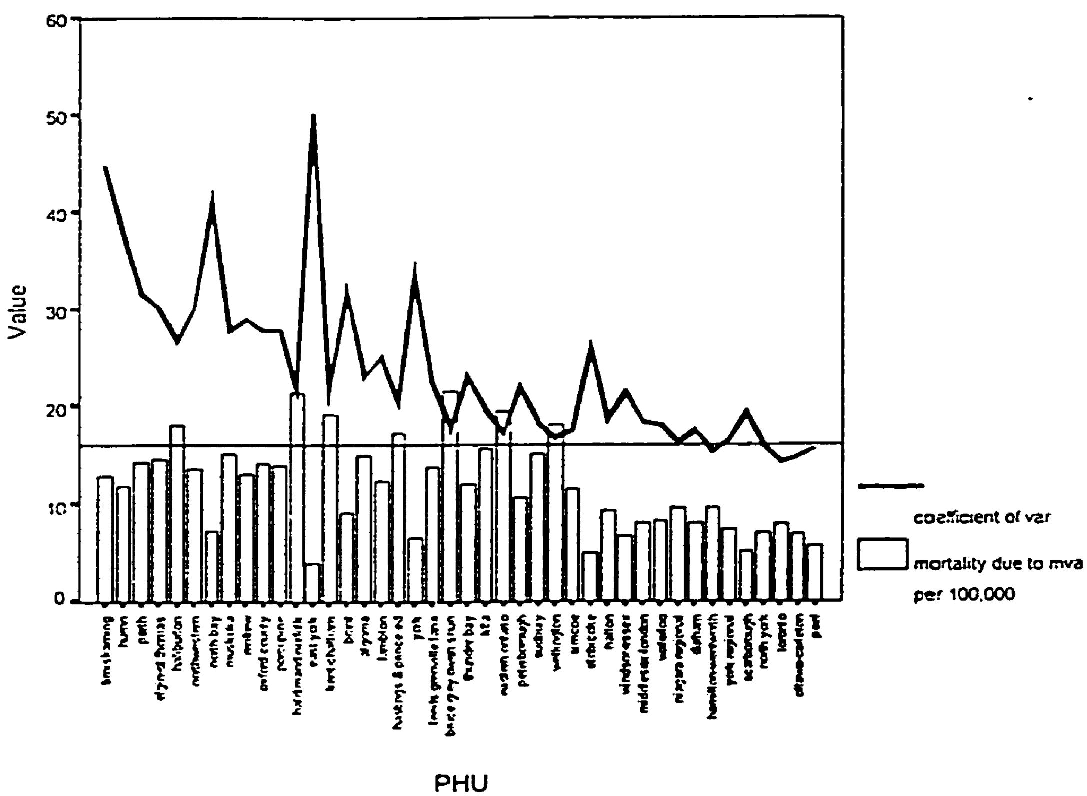

Value
0
2
4
6
8
10
12
PHU
coefficient of var
crude mortality rate
per 1000 populatio

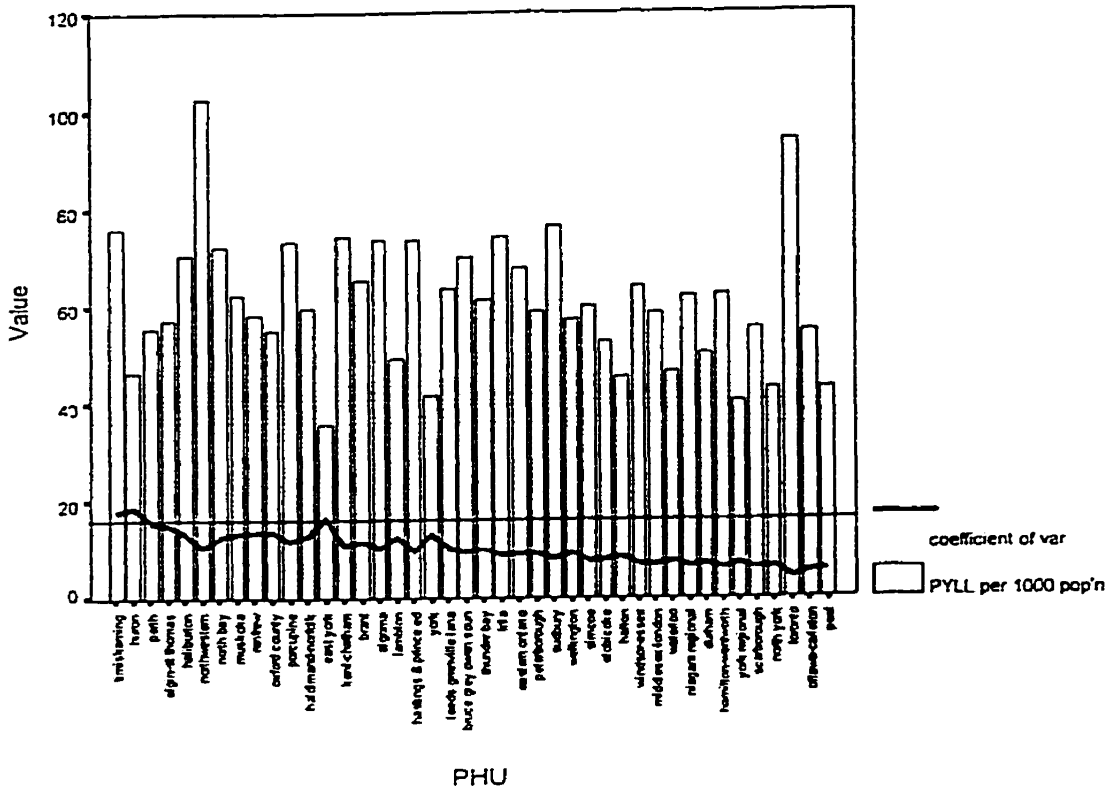

Value
0
10
20
30
40
50
60
70
PHU
coefficient of var
IMR
per 1000 live births


Value
PHU
coefficient of var
PMR per 1000 liveb and stillb
0
10
20
30
40

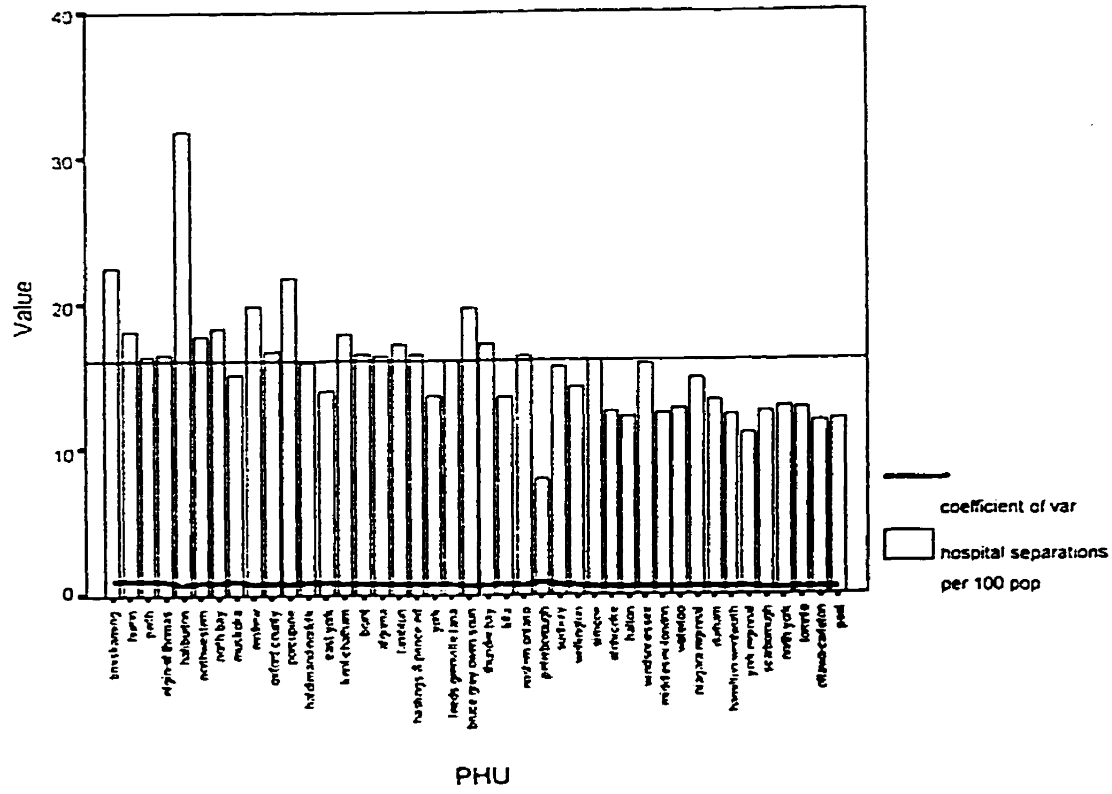

Value
PHU
coeficient of var
suicide mortality rate per 100,000
0
10
20
30


Value
0
2
4
6
8
10
12
14
16
18
PHU
coefficient of var
% contemplated suicide

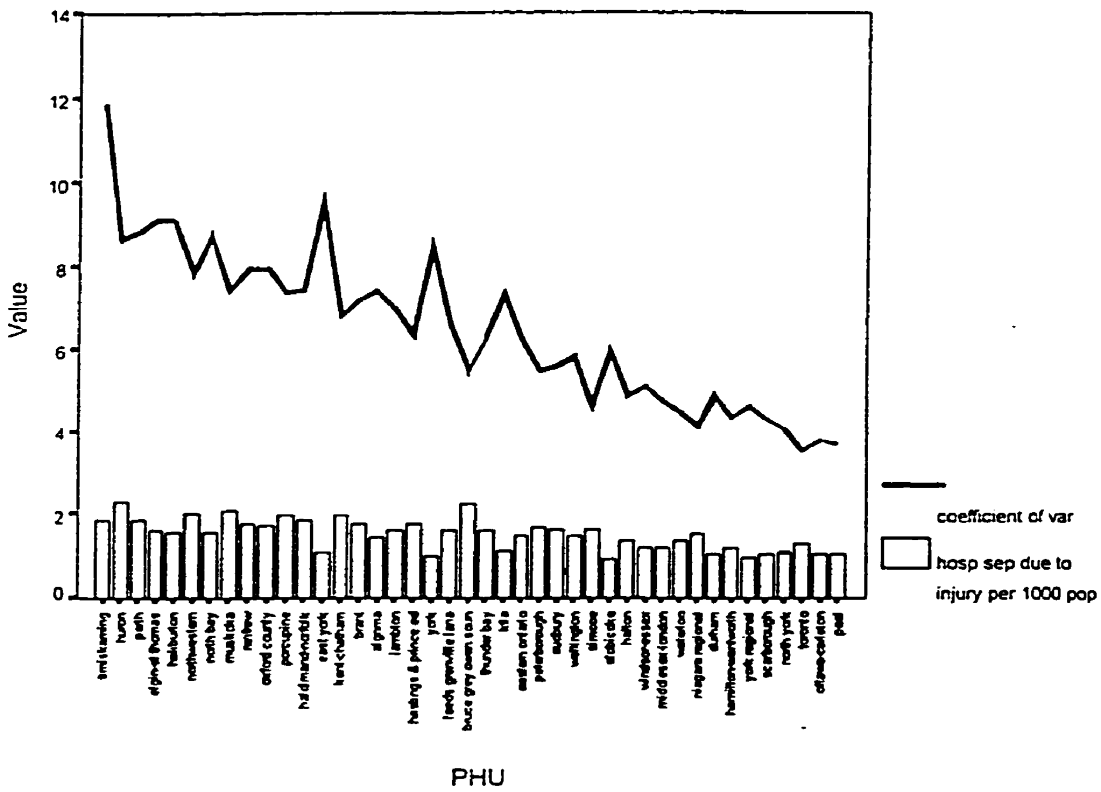

Value
0
10
20
30
40
50
60
PHU
coefficient of var
mortality due to mva per 100,000



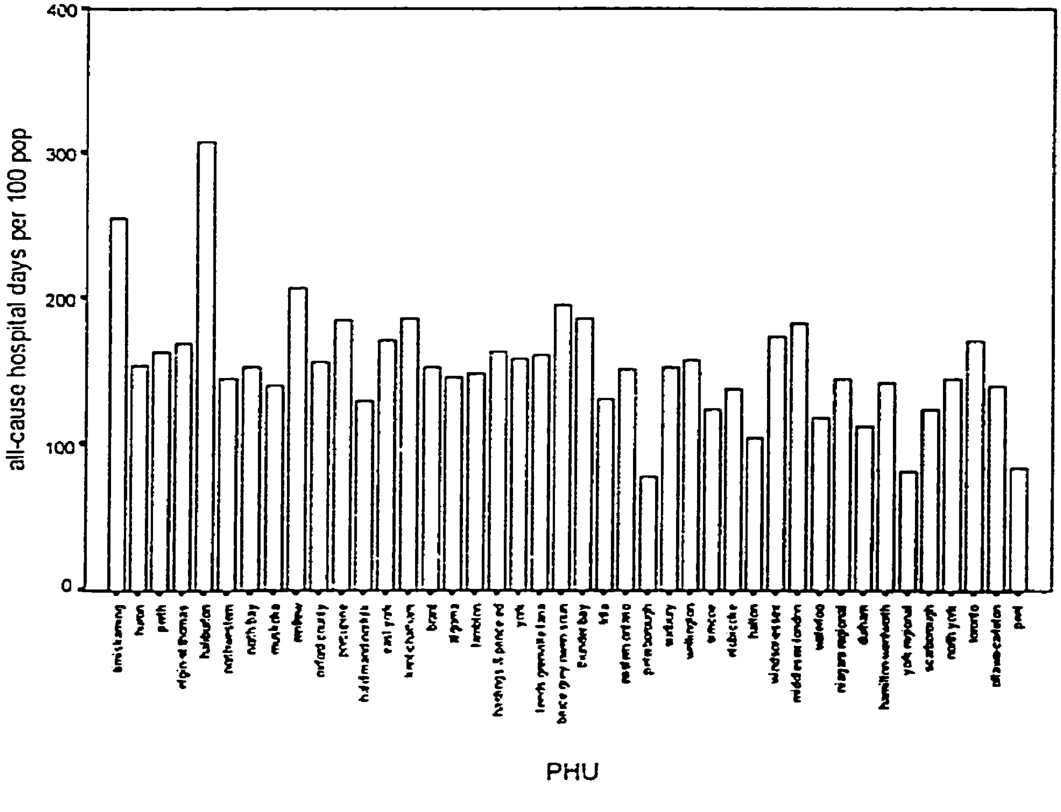
120
100
Value
PHU
coefficient of var
PYLL per 1000 pop'n



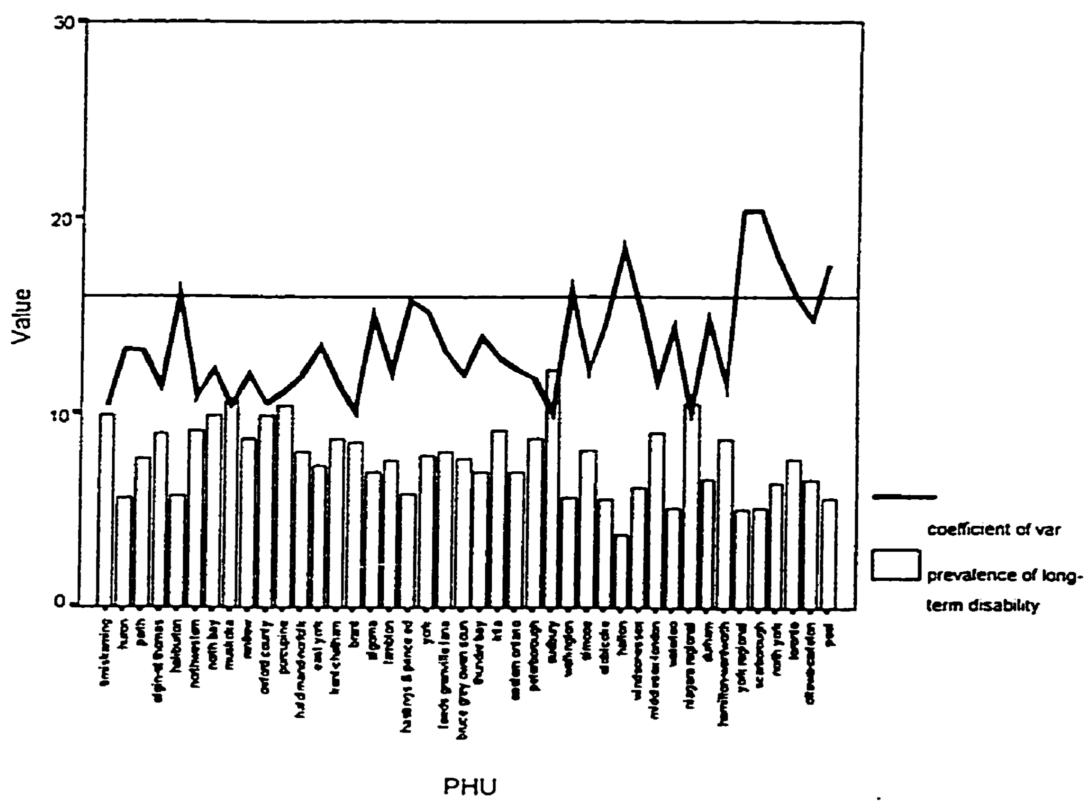
30
20
10
0
Value
PHU
coefficient of var
hospital separations
per 100 pop



Value
coefficient of var
hosp sep due to injury per 1000 pop
PHU



all-cause hospital days per 100 pop
PHU



30
20
10
0
Value
PHU
coefficient of var
prevalence of long-term disability