Canadian Studies in Population, Vol. 15 (2), 1988, pp. 135-158

A CASE STUDY APPROACH TO ONTARIO MORTALITY HISTORY THE EXAMPLE OF INGERSOLL, 1881-1972

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Résumé – En utilisant comme modèle la ville d'Ingersoll et ses communes, cette étude démontre la practicabilité, le potentiel et les restrictions de l'approche d'étude de cas à l'histoire de mortalité ontarienne. Elle décrit les sources documentaires disponibles et comment en recueillir des données; elle évalue la qualité des données et les utilise pour calculer les tendances en mortalité de la ville d'Ingersoll pour la période 1881 à 1972. L'étude présentée ici permet aux auteurs d'étudier d'autres aspects de la mortalité à Ingersoll et, d'une façon générale, de montrer comment des études de cas empiriques peuvent faire progresser la connaissance de l'histoire de la mortalité ontarienne au-delà de ce que les techniques normales d'estimation ont révélé.

Abstract – Using the town of Ingersoll and its contiguous townships as a model, the paper demonstrates the feasibility, potential and limitations of the case study approach to Ontario's mortality history. It describes the available documentary sources and how to assemble data from them, evaluates the quality of the data and uses the data to calculate Ingersoll mortality trends for the period 1881-1972. The work presented here enables the authors to study other aspects of mortality in Ingersoll and, more generally, show how empirical case studies can advance knowledge of Ontario mortality history beyond what standard estimation techniques have shown.

Key Words – **Ontario mortality, mortality history, historical methods**

Introduction

Scholarship on English Canada's mortality history is at an impasse. Although demographers have described Canada's long-term trends in mortality since the late nineteenth century (Bourbeau, 1982; McQuillan, 1985; Nagnur, 1986), little is known about details behind the trends. The explanation lies in a methodology limited to estimation techniques, which can only show general trends by age and sex for large populations. Conspicuously missing in the literature for English Canada are case study analyses of individual-level data. This study demonstrates the case study approach and discusses its potential and limitations.

Empirical case studies are essential to advance knowledge of English Canada's mortality history. To begin with, only the analysis of individual-level data can show important aspects of mortality, such as social class differences and patterns of mortality by cause of death. These data, in turn, are difficult to assemble, except for small case study populations. More than expedient, case studies are needed to elucidate local variation in mortality, a major feature of historical populations. Change in living standards, social class formation and other factors influencing mortality were local processes, and uneven economic development often enhanced differences among localities. Thus the sources of mortality decline, manifested in changing patterns of mortality by cause of death, varied greatly among countries and localities within countries (Condran and Cheney, 1978; Condran and Crimmins-Gardner, 1982; Fitch, 1984, Lynch, 1984). Case studies capture this local particularism better than time series data for large populations.

To show the feasibility of the case study approach, this article documents mortality trends for the Ontario locality of Ingersoll and its contiguous townships. The first part of the article elaborates the case study approach as a solution to problems with evidence and explains the selection of Ingersoll for the case study presented here. The second part describes available source materials and shows how to combine information from different sources to obtain the most complete record possible for local deaths. The third part assesses the completeness of deaths in the mortality file and how accurately these deaths represent the mortality experience of the local population. The last part presents mortality trends calculated from the period 1881-1972, compares the Ingersoll trends (as calculated) to the provincial trends (as estimated) and discusses the implications of the Ingersoll research findings for the case study approach.

Problems with Evidence, the Case Study Approach, and the Selection of Ingersoll

Problems with evidence bedevil any study of English Canadian mortality. Lacking a dominant state church, English Canada has no counterpart to the comprehensive church parish records (registers of baptisms, marriages and burials) that are the basis for studies of Quebec Roman Catholic and various European populations. To document mortality, therefore, one must rely primarily on secular records collected through government civil registration systems. Continuous civil registration exists only for twentieth-century years in most provinces, but in Ontario the compulsory registration of births, marriages and deaths dates from 1869 (Emery, 1983).

Provincial death registrations offer important advantages for the study of mortality; unlike parish records, for example, they report medically certified cause of death. Yet they missed many nineteenth century deaths and only gradually became complete. Thus calculations from early registration data are misleading; they appear to show rising mortality levels, but really show improved registration. The early data also are biased. As shown below, for example, they disproportionately underreport deaths in unskilled, working class households, thereby masking class differences in mortality, an important feature of nineteenth century populations. Similarly, although appearing to show that mortality rates are higher for urban than rural populations, the data really may show a better reporting of vital events in urban places, the reporting of rural vital events in urban places for reasons of convenience and the emergence of hospitals as central sites for births and deaths.

The local case study permits a partial solution to problems described above. Where death registrations for a given locality are incomplete, other documentary sources report local deaths which provincial registration misses. Thus combining reports of deaths from all sources (using record linkage to eliminate duplicate cases) provides a more complete record of local deaths than death registrations alone. Using various methods, one then may estimate how completely the additional sources report the missing deaths or, more specifically, when data from all sources become reliable.

Shown in Figure 1, the locality whose mortality is examined here comprises the Oxford County town of Ingersoll and its contiguous townships, North Oxford and West Oxford. Population in these municipalities increased from 4,462 in 1852 to 8,205 in 1901 and 12,402 in 1971. Ingersoll, incorporated as a village in 1852 and a town in 1865, held 27 per cent of the study area population in 1852, 56 per cent in 1901 and 63 per cent in 1971. Based on wheat and lumber exports in the 1850s, the local economy shifted to livestock

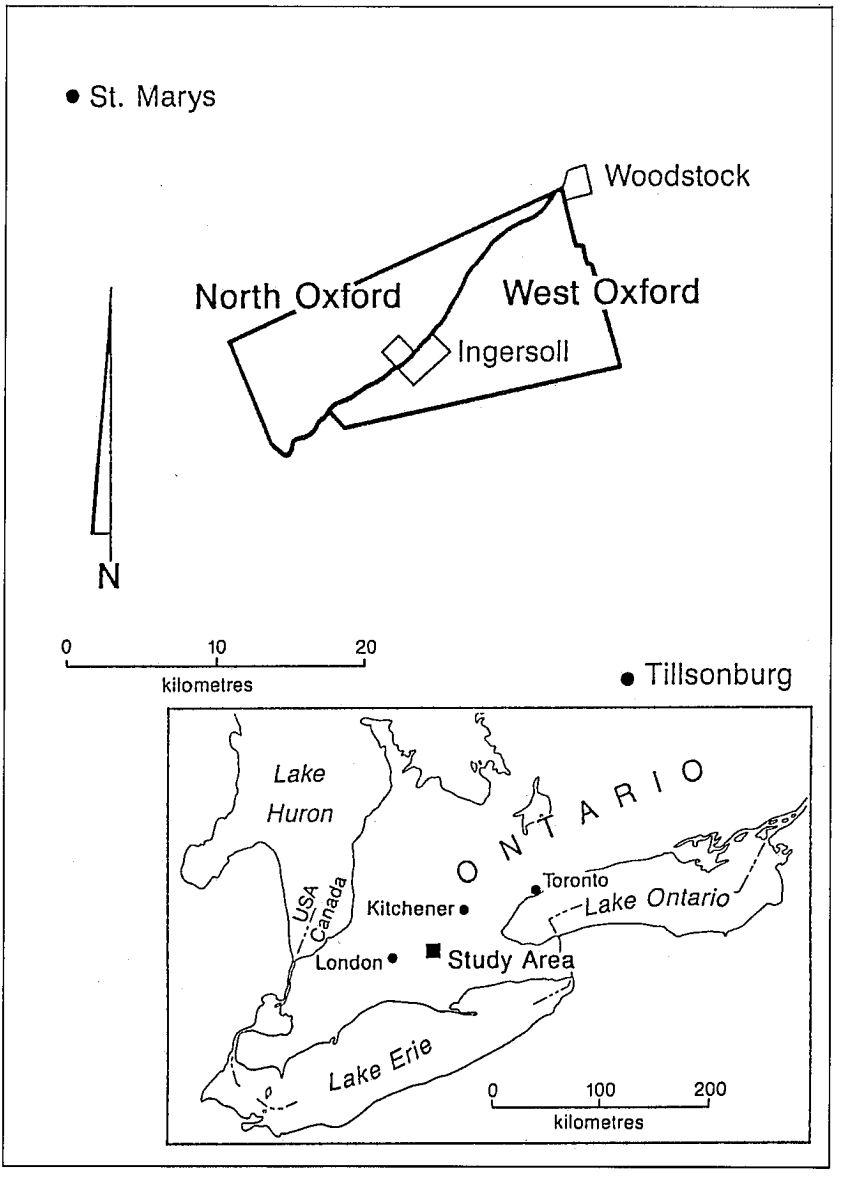

FIGURE 1. MAP OF THE STUDY AREA: INGERSOLL, NORTH OXFORD TOWNSHIP, AND WEST OXFORD TOWNSHIP

and dairy exports in the 1860s, while the town economy blended local service industries with industrial production for local and non-local markets. The opening of the Great Western Railway in 1853 sparked the early development of the town, but its location between London, Southwestern Ontario's regional metropolis 34 kilometres to the west, and Woodstock, the county seat 17 kilometres to the east, imposed upper limits on the town's economic and population growth.

The three municipalities are not a community in a functional sense. Though Ingersoll is at the centre of the two townships, the eastern ends of the townships abut Woodstock, the county seat. Thus Woodstock is the principal urban centre for persons in eastern extremities of the townships. Ingersoll, on the other hand, is the principal urban centre for certain rural populations to the north, south and west of the study area.

Ingersoll is eminently suitable for a case study. Its population is large enough to support statistical analysis and yet small enough to be manageable. Compared with larger urban places such as London, its locally occurring deaths also are more easily related to population, since fewer non-residents are involved. The inclusion of the two townships captures corporate Ingersoll's urban fringe and allows for the influence of town-township interaction on deaths reported for the town. As shown below, growing numbers of township residents died in the town hospital and town nursing homes. For the town alone, these deaths are "non-resident". With the townships included in the study area, however, the deaths are "resident" and can be related to the local population.

Assembling the Data

Investigation turns up six documentary sources with information on Ingersoll area deaths. The principal source, provincial death registrations, dates from July 1, 1869. Other sources include the burial register of the Ingersoll Rural Cemetery Company (founded in 1864); Ingersoll newspapers (1854-1919); the 1871 manuscript census mortality schedule; the Ingersoll Roman Catholic burial register (1850-); and the Ingersoll Church of England burial register (1838-).

The various sources, however, report deaths for different populations. Provincial death registrations report deaths occurring in the municipality, which include deaths of non-residents and miss deaths of residents which occurred elsewhere. In other words, death registrations report deaths for a population which differs somewhat from the municipal population. By contrast, the Roman Catholic and Church of England burial registers and the 1871 census mortality

schedule state a decedent's residence but not the location of death. The Ingersoll Rural Cemetery Company burial register lists all persons buried in the cemetery, regardless of where they died or had been resident. Newspaper death notices and obituaries report deaths which the editor deemed to be of local interest and also deaths of persons whose relatives paid for a notice (a 25-cent cost in the Ingersoll *Chronicle* during the 1890s). As both the burial register and newspapers report where a death occurred, one can select the locally-occurring deaths from these sources and use them in combination with death registrations.

Ideally one would select deaths by decedents' municipality of residence so that these can be related to the local population, which is represented by enumerated census populations and defined largely by residence. The nature of death registrations, the principal documentary source, however, requires selection by municipality of occurrence. Thus Ingersoll mortality data include cases from death registrations, the cemetery register and newspapers, but not the 1871 census mortality schedule and the Roman Catholic and Church of England parish records.

Death registrations provide the starting point for the Ingersoll mortality file. These include all deaths registered for the community from July 1, 1869 until 1942, and also for three-year clusters around later census years (1950-52, 1960-62 and 1970-72). Expedience justifies collecting data for later years for three-year clusters only. In the mid-1940s, the Registrar-General dropped the practice of filing death registrations by locality, which greatly increases the research time for assembling data on this basis. In 1975, North Oxford and West Oxford townships disappeared in a restructuring of Oxford County; thus the study period does not extend to 1980-82.

The second source on local deaths is the Ingersoll Rural Cemetery Company burial register. The mortality file includes all deaths reported in the register as having occurred in the study area before 1934 (an arbitrary cut-off point), but which are not in the death registrations. We give Ingersoll newspapers, the third source, lower priority than the burial register because they give less information. For 1896 and earlier years, the mortality file includes all newspaper-reported deaths which are stated to have occurred locally but are not reported in either of the other sources. Newspapers are not used for later years because, for reasons unknown to us, the Ingersoll newspaper reduced its coverage of vital events in 1896; at the same time, as elaborated below, death registrations had become virtually complete by then.

Information missing in death registrations, such as a decedent's age or cause of death, often can be added from a second source. Sometimes different documentary sources give conflicting information about a death. Of 1,772

deaths reported in both death registrations and newspapers, reported age differs by more than one year for six per cent (98 cases). Of 216 deaths reported in both town newspapers during the period 1876-79, reported age again differs by more than a year for six per cent (13 cases).

The three documentary sources hold some 18,000 reports of deaths for years covered in the study, including some 8,500 from death registrations, 6,800 from the Rural Cemetery Company register and 2,700 from newspapers.[1] Many deaths for early years are reported in more than one source; when duplicate reports are removed, some 9,000 unique cases are left. The file excludes 93 deaths registered for the study area but which really had occurred elsewhere, according to marginalia on the registration forms and information on residence in the cemetery register. Also excluded are 380 records of stillbirths, which we identified from information on age and cause of death.

Our analysis excludes at the outset the data for 1870 and earlier years which are manifestly incomplete. Figure 2 shows the composition of the Ingersoll mortality file by documentary source for the period 1871-1930.

The Problem of Decedent's Residence

The mortality file misses deaths of residents occurring outside the study area – for example, in the Woodstock hospital (opened in 1895) or a hospital in London. Yet it includes deaths of non-residents who perished in local traffic accidents, or who died in the Ingersoll hospital (opened 1909) or a town nursing home. Thus an important concern is whether deaths in the file – that is, locally occurring deaths – closely correspond to deaths of local residents.

Annual reports of the Registrar-General shed some light on differences between the two groups of deaths. Beginning in 1925, they give the number of "non-resident" deaths in Ingersoll municipal totals; and in 1944, they begin reporting deaths by decedents' residence (deaths of town residents in the town, plus deaths of town residents "elsewhere") as well as by where deaths occurred. Data on residence, however, are for the town only, not the entire study area. Thus Ingersoll "non-residents" include West Oxford and North Oxford township residents; similarly, an Ingersoll resident's death in one of these townships is classified "elsewhere".

A further problem is that published data do not report age and sex distributions for "non-resident deaths" and "deaths of residents occurring elsewhere". Lastly, residence classification is unreliable until 1930, when "place of residence" information was added to registration forms. Before then, classification was inferred from "length of residence at place of death" (information

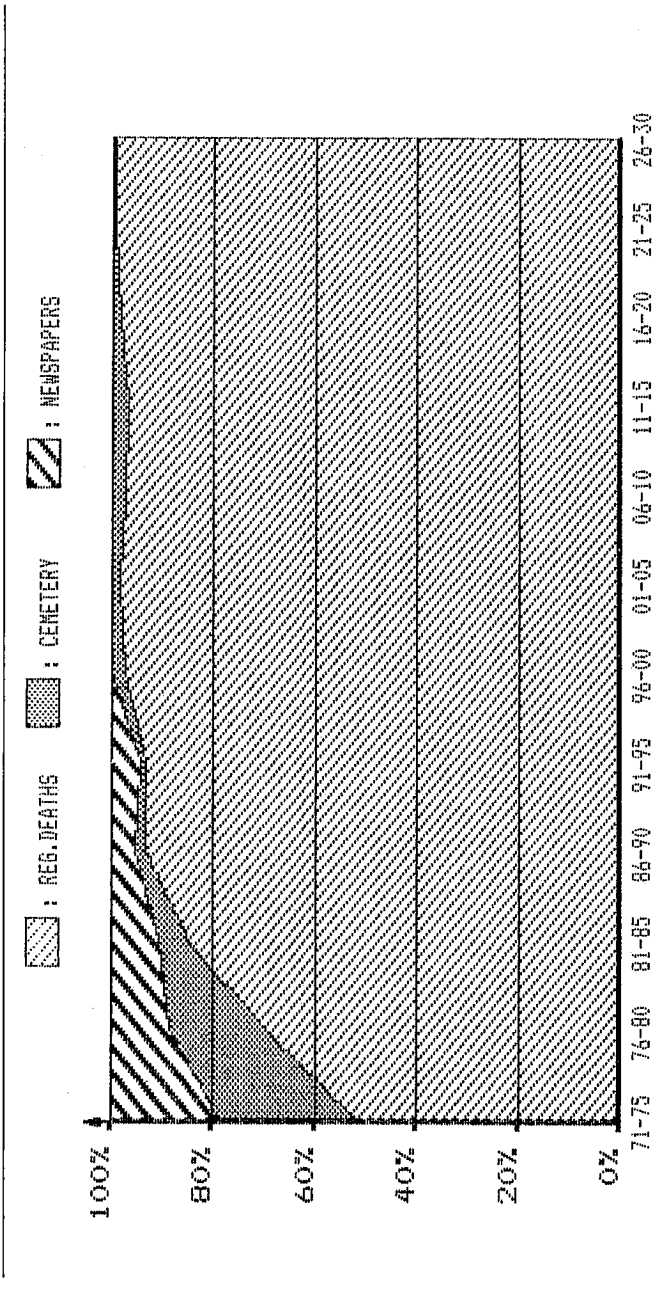

FIGURE 2. INGERSOLL AREA MORTALITY FILE: COMPOSITION BY DOCUMENTARY SOURCE FOR FIVE YEAR INTERVALS, 1871-75 TO 1926-30.
(N = 629, 619, 575, 640, 536, 553, 555, 531, 533, 551, 526, 513)

introduced to the forms in 1920); thus Ingersoll's published total of "non-resident" deaths for 1925 equalled the number of its decedents who had resided in the town less than seven days preceding their deaths.

Although information on the death registrations enables us to identify the "non-residents" who died in the study area for 1930 and later years, "residents who died elsewhere" are harder to locate. Given the impracticability of examining all provincial death registrations, we confined our search to Oxford and Middlesex Counties (which include Woodstock and London) for the three-year clusters 1930-32 and 1940-42.

The two-county search seems adequate for these periods. In township populations both in the study area and nearby, death usually happened at the decedent's home or in a nearby hospital. For the years considered here, 43 West Oxford and North Oxford residents died in Ingersoll (including 40 in the town hospital); seven died in Woodstock (including five in the hospital); three died in London hospitals; and one died in another township. The two-county search may be less adequate for deaths of Ingersoll residents outside the study area, but the numbers involved are small. According to published data for the town (which start in 1944 and whose "elsewhere" includes the two townships), 16 Ingersoll residents died "elsewhere" during 1944 and 1945. Of these we located eight by extending the two-county search to include these years.

Results of the two-county search for the 1930-32 and 1940-42 periods, reported in Table 1, show a close similarity between deaths occurring in the study area (that is, deaths in the mortality file) and deaths of study area residents. The numbers of "non-resident deaths" and "deaths of residents occurring elsewhere" are small, and the two groups of decedents are similar in number and population characteristics. We assume that a similar picture obtains for years before 1930, given that the trend for later years is toward smaller numbers of non-resident deaths, as one moves back through time. The two-county search is impractical for later years in the file (1950-52, 1960-62 1970-72). Beginning in 1946, registrations are filed as received rather than by county. Although the bound volumes of registrations are indexed by municipality, a major effort is required to locate county returns which are scattered among 240 some volumes for a given year. Moreover, the adequacy of the limited search is problematic for later years, when residents die outside the study area in greater numbers and probably in more dispersed geographical patterns.

Partial evidence indicates that deaths in the file for the later periods are increasingly different from deaths of residents. To begin with, "non-residents" increase from seven and 12 per cent of deaths in the file for the 1930-32 and 1940-42 periods, to 20, 19 and 31 per cent of the file for the 1950-52, 1960-62

TABLE 1. INGERSOLL AREA, 1930-32, 1940-42: DEATHS BY PLACE OF RESIDENCE (RESIDENTS DYING LOCALLY AND RESIDENTS DYING ELSEWHERE) AND BY PLACE OF OCCURRENCE (RESIDENTS AND NON-RESIDENTS DYING LOCALLY)

	Local Deaths of Residents	Non-Resident Local Deaths	Non-Local Deaths of Residents	Ingersoll Deaths by Residence	Ingersoll Deaths by Occurrence
1930-32					
Number	247	18	18	265	265
70+ Years	45 %	6 %	28 %	44 %	43 %
Infant Deaths	13 %	11 %	6 %	13 %	13 %
Female Deaths	49 %	28 %	33 %	48 %	48 %
1940-42					
Number	287	35	21	308	322
70+ Years	52 %	34 %	21 %	50 %	50 %
Infant Deaths	10 %	0 %	5 %	9 %	9 %
Female Deaths	47 %	37 %	48 %	46 %	46 %

and 1970-72 periods, respectively. Of "non-resident deaths" for the last three periods, 80, 74 and 83 per cent involved residents of Oxford County or the neighbouring Middlesex County township of South Dorchester. Their removal from the file makes little or no change (zero to two per cent) in the proportions of deaths involving infants, persons aged 70 or more and females.

We know neither the numbers nor population characteristics of the "residents who died elsewhere" after 1945. Published data for the town alone (whose "elsewhere" includes the two townships), however, show a substantial increase in such cases, from 15 in 1940-42 to 42, 68 and 50 for the next three three-year clusters. Together with township residents who died outside the study area (whose numbers are unknown), Ingersoll residents dying "elsewhere" probably are comparable in number to "non-residents" dying in the study area (65, 66 and 71), but population characteristics of the two decedent groups may differ.

To summarize, the validity of the case study approach requires a close correspondence between *deaths occurring in the study area* and *deaths of study area residents*. This condition is met for years before 1945, but for later years the two groups of deaths increasingly involve different persons. Thus, the case study approach may be problematic for the post-1945 period. Certainly the Ingersoll mortality trends which we calculate for the later period should not be taken too literally.

Completeness of the Data

The mortality file is suspect for deaths occurring in the 1870s. As shown in Figure 2, provincial death registrations in the file miss many of the deaths reported for the community in newspapers and/or the cemetery register. At the same time, the coverage of unregistered deaths in the two other sources is unknown. After 1880, however, the death registrations include most of the deaths reported in the two other sources; they furnish 85 per cent of all cases in the file for the 1881-85 period and more than 90 per cent of the cases for later years. This suggests that death registrations are increasingly complete after 1881, which means that the same holds for the entire mortality file.

To obtain a second indication of when the data become reliable, we use the Sekar-Deming technique to estimate their completeness for different time periods. Developed for use in third world countries whose population data are incomplete, the technique is appropriate for populations whose vital events are reported independently in two documentary sources. Death registrations and newspaper reports of deaths are the two sources used here. Although independent of each other, these sources are not wholly comparable, since civil registration aims to report all local deaths, whereas newspapers report them selectively.

In essence, the technique uses the relationships among three groups of deaths – deaths reported in newspapers only, in death registrations only, and in both sources – to predict the size of a fourth group, deaths reported in neither source (Crimmins, 1980; Sekar, 1949). Following the technique, we estimate the total number of deaths through the formula $((C + N1)(C + N2))/C$, where C represents deaths reported in both sources, $N1$ represents deaths reported only in death registrations and $N2$ represents deaths reported only in newspapers. Once the estimated total is known, we calculate the percentage completeness of deaths reported from particular documentary sources or combinations thereof. Table 2 summarizes the results of these calculations.

The estimates accord with the earlier indication of when death registrations become reliable. Death registrations are shown to be seriously incomplete for the 1870s, but their coverage sharply improves during the 1880s and is nearly complete by the 1890s. The estimates also indicate that the cemetery register and newspapers pick up most of the deaths missed by civil registration and that the mortality file is complete by 1881. By contrast, data for the 1870s appear incomplete and likely to understate actual mortality levels, thereby inflating estimates of life expectancy.

However, Sekar-Deming estimates exaggerate completeness where common bias (for example, a disproportionate underreporting of infant deaths) exists

TABLE 2. SEKAR-DEMING ESTIMATES OF COMPLETENESS, INGERSOLL AREA MORTALITY DATA, 1871-75 to 1891-95.

Period	Estimated Number of Deaths	Death Registrations % Complete	Newspaper Deaths: % Complete	Both Sources: % Complete	All Sources: % Complete
1871-75	714	45	65	81	88
1876-80	666	65	68	89	93
1881-85	568	86	75	97	101
1886-90	643	94	75	99	100
1891-95	544	92	73	98	99

in the two sources whose records are compared.[2] To test for common bias, we calculated Sekar-Deming estimates separately for deaths of infants, persons over 65, males and females, and then compared group estimates with those for the whole population. Shown in Table 3, the results suggest an absence of common bias by sex or age group. The completeness of death registrations for each population group is about the same as for the whole population. The exception, a disproportionate underreporting of male deaths in death registrations for the 1871-80 period, is not shared with newspaper reports of death.

Using occupations as the proxy for class, we also examined death registrations and newspaper reports of deaths for class bias. According to characteristics of their work tasks, occupations were assigned to one of five categories: non-manual complex, non-manual simple, manual complex, manual simple and unclassifiable (see Hershberg and Dockhorn, 1976; Pouyez and Bouchard, 1985). The last category includes occupations such as "gentleman" and cases without information on occupation.

The test for class bias is whether death registrations underreport deaths in households headed by persons with simple (unskilled), manual occupations. The answer requires information on the proportion of the Ingersoll population living in such households and the proportion of registered deaths reported for them. If death registrations are unbiased, these households normally would account for more than their proportionate share of deaths registered for Ingersoll. Our assumption here is that household populations in the category experienced higher mortality rates than the general population, in consequence of lower nutrition and living standards. Census enumerations probably disproportionately underreport persons in the category; this gives a second reason for expecting that mortality rates calculated from unbiased registration data will be higher for persons in the category than for general population.

TABLE 3. SEKAR-DEMING ESTIMATES OF COMPLETENESS, MORTALITY DATA FOR SELECTED POPULATION GROUPS IN THE INGERSOLL AREA, 1871-90.

Population Groups	Estimated Number of Deaths	Death Registrations: % Complete	Newspapers: % Complete	All Sources: % Complete
I. Sex				
1871-80: Males	662	44 (55)	55	98
1871-80: Females	656	56 (55)	67	92
1881-90: Males	602	90 (90)	75	98
1881-90: Females	608	91 (90)	76	100
II. Infant Deaths				
1871-80	257	51 (55)	62	94
1881-90	239	88 (90)	60	96
III. Age 65+				
1871-80	246	58 (55)	74	94
1881-90	304	90 (90)	79	96

Note: Estimates in parentheses are for the whole population

For each of the 1871 and 1881 census populations enumerated for the study area, we categorized persons according to occupation of their household head. To determine proportions of population in the various categories, each group was divided by the total population of classifiable persons. Thus calculated, households in the unskilled, manual category account for 21 per cent of classifiable population in 1871 and 19 per cent in 1881.[3]

Death registrations were harder to classify. Many decedents were infants, females or elderly retired persons, and had no reported occupation. In such cases, the occupation of spouse, father, household head, sibling or child was used for classification. Using record linkage (to newspaper death notices, community directories and manuscript censuses), we obtained information about decedent-related occupations for two arbitrarily selected time periods, 1871-74 and 1881-84. In this fashion, we were able to classify 71 per cent of the decedents for the first period and 85 per cent of the decedents for the second.

As shown in Table 4, civil registration disproportionately underreports deaths occurring in unskilled, working class households for the 1871-74 period.

TABLE 4. INGERSOLL AREA PERSONS IN THE UNSKILLED, MANUAL OCCUPATION CATEGORY AS A PROPORTION OF CLASSIFIABLE PERSONS: 1871 AND 1881 ENUMERATED CENSUS POPULATIONS AND DEATH REGISTRATIONS FOR 1871-74 AND 1881-84

	1871 Census Population	1871-74 Decedents	1881 Census Population	1881-84 Decedents
Number	1,646	36	1,494	59
All Cases	8,010	195	7,799	272
Proportion	21 %	19 %	19 %	22 %

Such households hold 21 per cent of the classifiable 1871 census population, but supply only 19 per cent of the unregistered deaths. By the 1881-84 period, however, the bias observed for the first period is not evident, or at least is sharply attentuated. The households in question provide 24 per cent of the registered deaths, though holding only 19 per cent of the classifiable 1881 census population.

As shown in Table 5, age characteristics of class groups in the two census populations are similar. This removes the possibility that unusual age characteristics of persons in the unskilled, manual category (for example, a disproportionately younger population) caused their underrepresentation in mortality data for the 1871-74 period, and that a disappearance of the unusual characteristics made the category's representation more proportionate in death registrations for the 1881-84 period. Thus the class bias in death registrations and newspaper reports of deaths is real for the 1871-74 period, as is its attenuation in death registrations by the 1881-84 period. This leads to two important conclusions. First, death registrations and the whole mortality file may be more incomplete for the 1870s than is indicated by Sekar-Deming estimates, which are insensitive to the shared bias. Second, the attenuation or disappearance of bias in death registrations confirms that these records are more complete by the second time period.

To summarize, three different measures indicate that the mortality file is complete for deaths occurring in the study area after 1880, but not for deaths occurring earlier. To press further the evaluation of the data, we turn now to consideration of the trends calculated from them.

TABLE 5. 1871 AND 1881 ENUMERATED CENSUS POPULATIONS FOR INGERSOLL AREA: AGE COMPOSITION BY OCCUPATIONAL CATEGORIES

	1871 Ø-14 %	1871 6Ø+ %	1871 Mean Age	1871 Median Age	1881 Ø-14 %	1881 6Ø+ %	1881 Mean Age	1881 Median Age
Non-Manual, Complex	38	4	24	22	34	4	25	21
Non-Manual, Simple	33	4	24	23	32	5	25	22
Manual, Complex	41	6	23	18	35	7	26	21
Manual, Simple	44	6	23	17	39	6	24	2Ø
Unclassifiable	2Ø	22	36	33	24	24	36	3Ø
No Occupation	31	1Ø	27	21	24	13	3Ø	22
Total	4Ø	6	24	19	34	8	26	21

Note: 1871 N = 8,675; No Data = 1. 1881 N = 8,658; No Data = 7

Trends Calculated from the Ingersoll Data

The crude death rates for the study area are the simplest measure of its mortality. To allow for random fluctuations in deaths for the small Ingersoll population, Figure 3 presents these rates for overlapping twenty-year intervals. In each calculation, the numerator is the average annual death total for the interval, and the denominator is the census population at the mid-point. The trend line shows a gradual decline, which accords with the known decline in provincial mortality levels for the study period. The adjusted trend line reflects a correction for a nine per cent undercount of deaths (the conservative Sekar-Deming estimate) in the 1871-90 period.

Death rates calculated separately for different age and sex groups furnish a more refined measure of mortality change. This is because mortality is age-related and the age composition of population changes. For example, persons aged 60 years or more moved from six per cent of the Ingersoll population in 1871 to 13 percent of the 1971 population; similarly, persons aged 15 years or less moved from 40 to 30 per cent of the population.

The calculation of rates for population subgroups requires information on age-sex distributions in census populations, which we obtained from manuscript census data for 1871, 1881 and 1891. The manuscript data for later censuses are closed to research, and the published data commonly do not give information at the municipal level. Thus for the 1901 community population, we assumed the age-sex distribution published for the South Oxford census

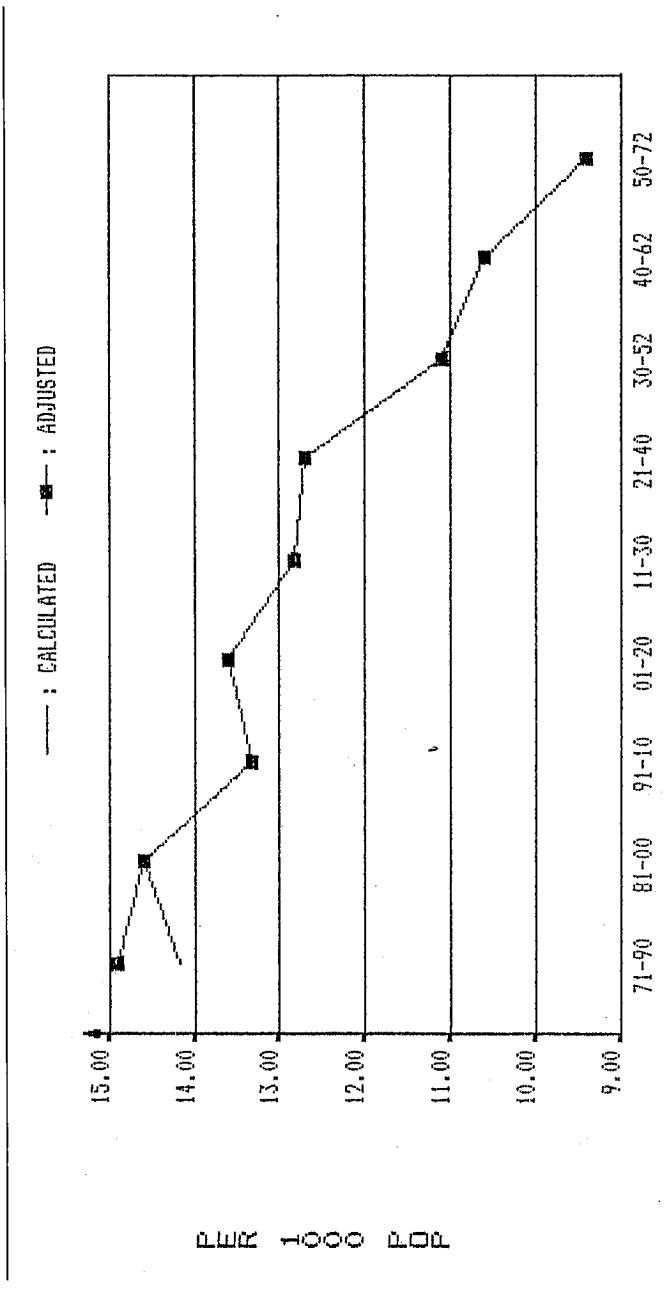

FIGURE 3. CRUDE DEATH RATE AND ADJUSTED CRUDE DEATH RATE FOR THE INGERSOLL AREA, 1871-90 TO 1950-72.

district, which contained the community. The 1911 and 1921 census publications report age-sex distributions for Ingersoll but not the townships. Thus we gave the township populations the age-sex distributions published for the rural sector of the South Oxford census district. The censuses 1931 through to 1961 lump the infant and 1-4 ages into a single category, and the 1951 and 1961 censuses similarly reduce the number of categories for persons in the 25 to 64 age range; in these cases, we estimated how the population in the broad categories was distributed among the smaller categories used in our analysis.

Inaccuracies in census data affect the computation of mortality rates. Particularly for infants and children, nineteenth-century censuses commonly underenumerate population, thereby inflating mortality rates as calculated (Henripin, 1968). They also show "age-heaping", a tendency of respondents unsure of their age to answer in round numbers. This leads to artificially large numbers of people at ages such as 40, 50 and 60. Where age reporting is of poor quality, ages of elderly persons commonly are overstated, which inflates the number of persons in the older age categories and deflates death rates calculated for them. Census data for the community are used without adjustment, however, because one cannot reliably distinguish between systematic errors and random variability in the age distribution of a small population.

Age-specific death rates, reported in Table 6, are calculated similarly to crude death rates. For each age group, the average number of deaths occurring over a 20-year period is divided by the number of persons in that category at the mid-point of the interval. Asterisks indicate where Ingersoll rates differ by 15 per cent or more from estimated provincial rates.[4]

The results for the early decades show the expected "U-shaped" pattern of mortality by age, in which risk of death is high in infancy and early childhood, and declines rapidly through later childhood and adolescence before beginning a gradual ascent to high levels in older age. Death rates for all age groups declined over time, but the largest declines were centred on infancy and early childhood.

The age-specific death rates presented in Table 6 were used to calculate period life tables for the Ingersoll area population. Table 7 reports the estimates of expectation of life at ages 0, 20, and 65, and also the corresponding estimates for Ontario.

Over the entire study period, life expectancy at birth for Ingersoll males increased from 50 to 70, while the provincial figure rose from 46 to 68. The data on life expectancy at age 65 confirm the well-established view that length of life past age 65 has changed little through time. Most of the gain in expectation of life at birth came from reductions in the risk of death in the earliest years of life. Males gained less than females and in a different rhythm. Whereas

TABLE 6. AGE-SPECIFIC DEATH RATES (PER 1,000) FOR THE INGERSOLL AREA, 1871-90 TO 1950-72

Age	1871-1890	1881-1900	1891-1910	1901-1920	1911-1930	1921-1940	1930-1952	1940-1962	1950-1972
				Males					
0	130*	173	117*	118	107**	94**	76**	36	18*
1-4	16*	14*	11*	8*	6*	6**	3	1	1
5-9	6	4	3	3	2	3**	1	1	1
10-14	3	2	2	2	2	2	0*	0*	0
15-19	5	4	2	3	3	2	2	1	1
20-24	5	7	6	4	3	1*	1*	2	1
25-29	9	6	3	4	4	3	1*	1	1
30-34	7	6	6	5	5	4	1*	0*	1
35-39	11	8*	6*	6	5	4	4	3	2
40-44	10*	8*	3*	5*	6	5	3*	3	3
45-49	10*	10*	8*	8*	6*	9	6	6	3*
50-54	11*	13*	11*	10*	9*	9	7*	9	9
55-59	17*	20*	12*	17*	18	20**	16	15	13*
60-64	20*	18*	22*	23*	22*	25	22	28	25
65-69	27*	36*	35*	32*	40	41	40	36	37
70+	93*	97*	101*	105	79*	81*	77*	91	91
				Females					
0	95*	111*	120	112**	74	73**	58**	26	15*
1-4	20	18	10*	8	4*	3	3**	1	1
5-9	7	4	3	3	2	1	0*	0	0
10-14	4	4	2	2	1	0*	0*	0	0
15-19	5	4	3	2	2	2	0*	0	0
20-24	8	7	6	4	3	2	1	1	1
25-29	9	6	6	6	5	3	1*	1	1
30-34	9	7	6	6	5	4	3**	2**	1
35-39	0	13**	9	9	7	4	2	2	1
40-44	8	9	9	8	5	5	4	2	1*
45-49	11	10	8	8	9	7	5	3*	3
50-54	10	14	18**	15	9	8	7	7	6
55-59	21	15*	14*	16	16	12	8*	8	9
60-64	25	25*	23*	28	23	22	23**	18	14
65-69	33	55**	39	28*	34	26*	29	27	23
70+	82	83*	89*	83*	93	103	85	81	76

Note: * = 15 + % lower than the estimated provincial rate.
** = 15 + % higher than the estimated provincial rate.

male advances in life expectancy were clustered at the beginning and near the end of the study period, female advances were distributed evenly through time. The Ingersoll data show excess female mortality at the outset of the study period, followed by excess male mortality after the 1901-20 interval (where *ex-*

TABLE 7. EXPECTATION OF LIFE AT SPECIFIED AGES, INGERSOLL AREA AND ONTARIO, 1881-1900 TO 1950-72

Age	1881-1900	1891-1910	1901-1920	1911-1930	1921-1940	1930-1952	1940-1962	1950-1972
				Ingersoll Males				
0	50	57	57	58	60	64	69	70
20	45	48	49	48	48	50	52	52
65	11	13	14	12	12	11	14	13
				Ontario Males				
0	46	49	55	58	61	65	67	68
20	41	42	45	46	49	50	51	51
65	11	11	11	12	13	12	13	13
				Ingersoll Females				
0	50	54	58	62	66	69	73	75
20	42	45	48	48	52	54	55	56
65	9	12	16	14	16	16	15	16
				Ontario Females				
0	49	52	58	62	64	68	72	75
20	43	44	46	49	50	52	55	57
65	11	12	12	13	13	14	15	16

cess refers to the amount by which mortality levels for one sex exceeded those for the other).

Although Ingersoll's mortality experience (as calculated) is broadly similar to provincial experience (as estimated), certain differences are noteworthy. For example, the adult male mortality for Ingersoll before the 1911-30 period is markedly below the provincial level (and also the levels for Ingersoll and Ontario females). Similarly, as shown in Figure 4, Ingersoll's excess female mortality at the beginning of the study period contrasts with the consistent excess male mortality in the provincial pattern. The provincial estimates may exaggerate real sex differences between the community and provincial patterns. Standard estimation techniques consistently fail to predict actual sex differences in mortality and understate how these changed through time. As recently shown, they overstate excess male mortality in high mortality conditions (which works against a finding of excess female mortality) and understate the male excess in low mortality conditions (Vallin, 1983).

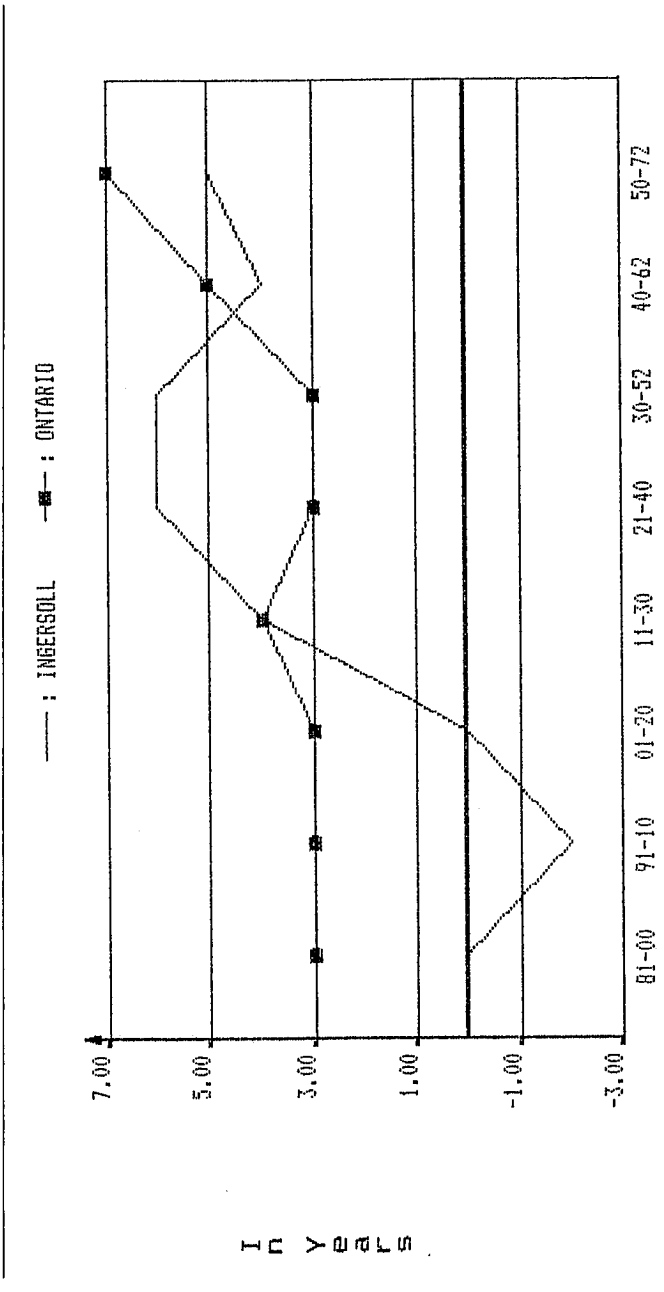

FIGURE 4. FEMALE ADVANTAGE IN LIFE EXPECTANCY AT AGE OF BIRTH, INGERSOLL AREA AND ONTARIO, 1881-1900 TO 1950-72.

The play of small numbers may also influence the adult rates for Ingersoll males, or the mortality file may underreport male deaths before the 1911-30 interval, with a particularly severe underreporting for the 1891-1910 interval. Although we do not rule out an underreporting of male deaths as a possibility, various statistical tests fail to identify sex bias in the mortality file for the 1871-96 period. Moreover, the hypothetical severe underreporting of male deaths for the 1891-1910 interval works against our findings (described above) that the mortality file is more complete for these years than for the 1881-1900 interval.[5] To summarize, we cannot clearly resolve how much of the difference in sex trends between the Ingersoll and Ontario patterns is real. At a minimum, our results suggest the need for further research into this aspect of mortality.

Conclusion

Our research findings show the feasibility of the case study approach. For 1881 and later years, the data assembled for Ingersoll appear to be inadequate for identifying local trends. As calculated, the Ingersoll trends are for the most part unexceptional. Indeed, their chief use here is to help validate the case study approach by showing their accord with trends estimated for the province. Certain findings, however, hold additional interest. In particular, the Ingersoll pattern for sex differences in mortality challenge conventional wisdom and invite further investigation. More generally, differences between the Ingersoll and provincial mortality patterns signal how case studies can document local variation in Ontario mortality experiences.

Future work with the Ingersoll data should elaborate local conditions which influenced the trends. The analysis of mortality by cause of death, for example, can show the relative importance of different environmental influences, such as food, water and air contamination, birthing and weaning traditions, and nutrition levels. Similarly, a class-specific analysis can shed light on social differences in access to features of the local environment.

If the potential of the case study is clear, so too are its limitations. Incomplete data make the Ingersoll study impractical before 1881, and the problem of decedents' residences makes it problematic after 1945. Even within the 1881-1945 period, we cannot clearly answer whether adult male deaths were underreported for the early intervals. Especially for subgroups within the population, random fluctuations due to small numbers also may mask the real trends. To summarize, the case study can move knowledge beyond what estimation techniques have shown, but it also raises new questions and fresh ambiguities.

Acknowledgments

We thank the Hannah Institute for the History of Medicine and the Centre for Canadian Population Studies at the University of Western Ontario for research funds; Mrs. Rosemarie Gage, deputy Registrar-General of Ontario, for access to death registrations; Edward Phelps, the Regional Collection Librarian at Western, for support in the gathering of documentary materials; J.J. Talman for detailed stylistic criticisms; Nancy Bouchier for the use of graphics software; and Gail Campbell, Joyce Minielly, Angela Kee, Rob Howell and Jeanette Berry for computer data entry.

Footnotes

1. From November 1876 to October 1879, runs of two town newspapers are extant. Of 277 study area deaths reported in the two papers, 216 appear in both papers; 34 appear only in the *Tribune*, a Conservative party paper; and 27 appear only in the *Chronicle*, a Reform (or Liberal) party supporter.

2. For example, for 100 deaths, comprising 20 deaths of infants and 80 deaths of others, assume that each source misses all infant deaths but fully reports the others. Applying the estimation formula, the estimated number of deaths is 80, and each source is estimated to be 100 per cent complete. To minimize "the effect of correlation between events missed on both lists" Sekar and Deming suggest "dividing the population into homogeneous groups and calculating the total number of events separately for each group; then by addition getting the grand total." This procedure is impractical here. The sole common bias we detected was by class, and our proxy for class (occupation of household head) is too imprecise to allow reliable findings.

3. The unclassifiables include occupations such as "gentleman" and cases without information on occupation. In Table 4, the "totals" exclude unclassifiable cases, which are reported separately, along with the proportion they represent of all cases. Household heads with no reported occupation or an unclassifiable occupation were linked to study area directories for enumeration years for possible information on occupation. Linkage findings produced classifiable occupations for some of these household heads, so the proportion of unclassifiable persons in enumeration populations fell from nine to eight per cent for 1871, and from 13 to 10 per cent for 1881. Reported in Table 4, the revised calculations did not change the proportion of the 1871 enumerated population living in households in the unskilled manual category, but the proportion increased for the 1881 enumerated population, from 18 to 19 per cent.

4. Ideally the infant death rate is expressed as the number of deaths occurring per 1,000 live births. Census data rather than birth data are used here, however, because birth registra-

tions are seriously incomplete before World War II (Emery, 1983). McQuillan describes the estimation procedure used for the 1881-1930 period (McQuillan, 1985). For later periods, the estimations are from Nagnur's life tables for mid-point years (Nagnur, 1986).

5. Estimates obtained through the Sekar-Deming method reveal no sex bias in the data (see Table 3). A second test found slight but unconvincing evidence that older-aged male decedents were undercounted in death registrations, the principal documentary source in the file. Of 2,334 deaths reported in newspapers for the 1871-95 period, 76 per cent were linked (also reported in) to death registrations and 24 per cent were not. Using contingency table analysis and related measures of statistical association, we found that sex alone was not related to linkage status at the 0.05 level of significance. However, linkage showed a slight positive association with age category (an *eta* statistic of 0.11198), which held only for females (0.16066) when examined separately by sex. Assuming an underregistration of infant and child deaths for both sexes, an underregistration for all age groups could explain the absence of age bias in linked death notices for males. That being said, this hypothesis rests on a statistical association of low magnitude and which ceases to be statistically significant when examined separately for five year intervals within the 1871-95 period.

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Received November 1986; revised May 1987.