MANITOULIN ISLAND IN TRANSITION:

AN ECO-EPIDEMIOLOCIAL EVALUATION OF LATE 19th AND EARLY 20TH CENTURY MORTALITY

by

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Abstract

Exploring data from the past provides insightful perspectives, particularly in health and disease causation. More recent anthropological perspectives of the epidemiologic transition revisit the significance that social factors play in disease causation and the evolution of diseases over time. Exploration of historical mortality records can reveal important insights into the health of historical societies and changes in disease trends (Defo, 2014; Mercer, 2014; Zuckerman, Harper, Barrett, & Armelagos, 2014). This study applies eco-epidemiologic concepts to extract a contextually appropriate representation of the cause of death trends as well as non-specific mortalities and their plausible risk factors using both death records from Manitoulin Island (1870-1908 and 1921-1936) and other relevant data and literature, eco-epidemiological perspectives reflecting ecologically derived reflections of epidemiologic concepts.

The analysis found the data to represent a contextual environment that experienced a period of rapid expansion of settlers and immigrants in the late 1870s to early 1880s, to a place that had prior to the 1862 Manitoulin Island Treaty been restricted to Indigenous People. The unrefined record collection techniques of this period resulted in datasets that are inadequate for most statistical interpretation methods.

The time period of study is especially interesting as it represents the transition between the colonial era and the modern, industrial era. Consideration of the epidemiologic transition model (Omran, 1971; Omran, 1977) especially highlights the influence this immense societal change had on disease impacts and the pathology of the environment. Historical ecology

considers the influence humans have on their environment that in turn impacts heath trends that are notably represented geographically. To address this phenomenon in research of death trends requires multi-level approaches in order to address the complexity of factors and degree of impact. This is achieved in application by considering the intersection of disease pathways and the environment, particularly using the multi-level eco-epidemiological life course framework (Defo, 2014).

Epidemiologically, the dataset overall is more reflective of Omran's (1971) 'age of receding pandemics' and possibly beginning the transition into the next age. Abridged life tables suggest a poor survival rate of 17 years at birth. Tuberculosis was the most notable cause of death with respiratory complications causing almost one third overall. The new immigrants to the island were an older population, whose survivability reflects a disease profile that is based more on a prior contextual environment that leads to chronically related diseases. The settlers, colonialists who were born in North America died at a much younger age, including a high proportion of infants. In this group, the adults and elderly were more apt to die from chronic complications, particularly a result from cardiovascular impacts.

Evaluating death trends and exploring past heath and disease impacts using artefactual documents and relevant literature, particularly death records, provides insight into overall environmental impacts on disease trends. While this analysis reflects more socio-ecological interpretations of trends in death on Manitoulin Island due to data quality, it does add to the fragmented view of Canada's epidemiologic and demographic transitions following confederation. It also brings forwards insightful understandings into the history of Indigenous relations and the Canadian identity.

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CHAPTER 1. INTRODUCTION

Health and disease are complex concepts that extend across many conceptual environments. As it is possible to explain trends in disease causation through population data variables and to predict future trends by exploring past and present trends, a reflection in the application of epidemiology (present), and social epidemiology (past), then it should be considered obligatory that investigation into these trends reflect their contextually-defined environments (Bhurga, 2014; Defo, 2014; Krieger, 2001a; Krieger, 2001b; Mercer, 2014; Zuckerman, Harper, Barrett & Amelagos, 2014). Application of social, or historical, epidemiology when exploring past disease trends through death records can illuminate important determinants in health risk, patterns of morbidity and resulting cause-specific mortality. Furthermore, these data (and supporting data, such as birth registrations and census enumerations) that represent a defined location and time period, or exhibit a health-related event (e.g. epidemic, pandemic, migration) have the potential to produce significant and useful results that could supplement research in disease understandings (Defo, 2014; Hardy, 1994; Krieger, 2001a).

This study explores the impacts of disease on Manitoulin Island (Ontario, Canada) particularly through death records that extend from 1870 to 1908 and 1921 to 1936. The analysis reflects that of an *eco-epidemiological* approach as it considers an ecologically-based framework in interpretation of the cause of death trends. The contextually-defined environment plays a particularly significant role in this location prior to and during the time period of this analysis.

The most influential part of exploring and analysing disease and death trends is defining the contextual boundaries of the geographic region of study and time frame the data extends across (Krieger, 2001a; McLaren & Hawe, 2005). Historical records imply a retrospective approach that mean observations are dependent on the adequacy of the data available (Ludlow, 2017). Initial inquiries into the dataset resulted in questioning the reliability of Manitoulin Island data due to, but are not limited to: poor data collection prior to 1921 in Canada; a history of colonisation of Indigenous Peoples; the isolated, diverse, island environment; and rapid development of the island involving immigration impacts. These impacts are explored in the literature review in Chapter 2.

Consideration of these factors on not only the availability of records but the impact of disease processes during the time frame requires a multi-level analysis to incorporate the many factors that could result in the death trends observed. Analysis therefore draws upon an eco-epidemiologically defined method of application that specifically considers historical ecology, or intersections of the human-impacted environment (Balée & Erickson, 2006), on the transition of disease impacts which coincides with population growth, as defined by the epidemiologic transition. The multi-level analysis is outlined in Chapter 3.

The epidemiologic transition model, which reflects high infectious disease mortalities and low life expectancy transitioning to more degenerative-related mortalities and higher life expectancy is displayed in Omran’s (1971, 1977) model in three foundational stages. The model is commonly used in application of social epidemiology as an investigative tool to address historical data during the period of the industrial transition. The consideration of other models, however, can supplement further understandings of the multiple factors that impacts disease causation. The multi-level analysis combine more contemporary models to the epidemiologic transition model, particularly Defo’s (2014) multi-level eco-epidemiologic model, which better considers the intersection (Bauer, 2014; Crenshaw, 1989) of disease pathways with different contextually-defined societal environments to determine pathways of plausible impacts in disease processes (Defo, 2014; McLaren & Hawe, 2014; Zuckerman, et al., 2014).

The analysis connects the historical narrative of Manitoulin Island, related disease trends in North America, and understandings of social (historical) epidemiologic analysis to extract an understanding of death trends. These trends are compared to the epidemiologic transitional ages and the results of the analysis are provided in Chapter 4 which are then discussed in Chapter 5. Chapter 6 explores the potential this type of research and this data, in particular, has to be evaluated in future work. Research questions that guided initial exploration:

1. What is the history of Manitoulin Island prior to, and during the period of study?
2. How does the history and resulting environment influence the interpretation of the data?
3. What is the epidemiologic transition model and how is it applied to mortality data research?
4. What does other historical sources and datasets add to support this analysis?

CHAPTER 2. LITERATURE REVIEW

2.1 Introduction

Population data are collected globally and are used for a variety of purposes, most commonly as a tool in investigative research. Using population data to research health must consider multiple variables which intersect within the boundaries of the context which they are found. These variables are defined by geographical region and period in time. Consideration of the context is important particularly when considering mortality (or death registration) data as there are numerous potential risks factors than can contribute to the event of death. Using death records to explore multiple risk factors, or multifactorial causation of disease, however can contribute to understandings regarding the transition of disease impacts over time (Bauer, 2014).

Disease impacts are most notably different geographically on a micro to macro scale. Smaller regions of a larger society are not only expected to display different trends in societal distinctions (class, culture, age, etc), but also varying disease and ultimately death trends. These variations in populations become apparent in differential health status as a reflection of environmental exposure, or exposure to the risk of life. Risk factors to health are most important in terms of societal marginalisation and *inequalities* (defined as unfair between groups of people) (Ludlow, 2017).

Generally, assessment of population data requires a multilevel analysis, dependent on complex factors that are constructed based on available data for measure and that control the direction of the investigation (Bhurga, 2014; Porter 2002; McLaren & Hawe, 2005). However, the development of broader frameworks to understand these complex factors and how they interact with the human environment, and successful application are necessary in order to refine this analysis process (Defo, 2014; Mercer, 2014; Saracci, 2007; Zukerman, Harper, Barrett & Armelagos, 2014).

This study addresses population data, specifically death records (1870-1908 and 1921-1936) from Manitoulin Island. The scope of this literature review includes population data analysis and history consistent with the social epidemiological perspectives of North America. It takes particular care in the representation of the Indigenous People data, as the history of the region significantly impacts research processes that cannot be considered without this perspective of Manitoulin Island.

This review also encompasses the dynamic features that provide understanding into social epidemiological perspectives in population data analysis (section 2.2), comparable epidemiological representation of the contextually-defined landscape (time and place) assessed in this study (section 2.3), a framework that simplifies impacts of disease pathways within the human environment (Defo, 2014) (section 2.4), and a review of the significance of the region of Manitoulin Island in Canadian history and this study (section 2.5).

2.2 Population Data in Research

In Canada, population data are managed by Statistics Canada. Civil registration began in Ontario on July 1, 1867, the day of Confederation. This process involved the registration of births and deaths by the division of counties that made up larger districts. A change in census documentation occurred in 1871 with the transfer of population data from the Dominion Bureau of Statistics to the newly established Statistics Canada. For the government, the census is used to determine the representation of seats that can be held by the electoral district within the government. Compared to other governments of the time, Canada was slow in developing an efficient system of national registration (Paterson, 2018; McInnis, 2000a; McInnis, 2000b; McQuillan, 1985).

It was not until 1931 when a reliable national system to collect vital statistics (registration of births, death, and name changes: marriage, adoption, etc.) was fully in place. Mortality records collected prior to the when the process was transferred to the Dominion Bureau of Statistics in 1921, are a poor reflection of the population they represent. Emigration and immigration are difficult to trace; however, there are enough data to deduce some crude rates and interpretations (McInnis, 2000a; McInnis, 2000b) that are reviewed in the next section.

In 1851, the British Colonies begin enumeration. In 1851-2, the first census was conducted for Upper and Lower Canada (established in 1791) (McInnis, 2000a). Another was conducted in 1861 before the decennial (every ten years) census was mandated in the Constitution Act (1867) and continued on from 1871 (Paterson, 2018; Wightman, 1982). Census data is particularly useful in population research as it can provide insight into economic variables important to societal organisation and the production and distribution of wealth (Bauer, 2014; Krieger, 1992; McGibbon & McPherson, 2011).

Using population data to explore etiological patterns, or patterns in the causation of disease, is known as epidemiology. Specifically, within the field of medicine, epidemiology traditionally refers to the study of specific diseases within restricted time frames, such as during an epidemic or pandemic. Research conducted by epidemiologists conceptualises diseases as singular entities that are attributable to immediate and proximal causes (Zukerman, et al., 2014).

Compared to traditional epidemiology, social epidemiology addresses data from a specific geographical population and considers community level attributes as influences on health (Krieger, 2001a; Krieger, 2001b; McLaren & Hawe, 2005). This approach conceptualises diseases as components of broader health trends attributable to longer-term, root causes. These are referred to as degenerative complications, and often reflect chronically defined conditions like heart disease, arthritis, and other system failures. *Chronic* is defined as lasting six months or longer versus *acute* which lasts less than six months (Saracci 2007; Zukerman et al., 2014).

The application of social epidemiology on population datasets, specifically death records (historical data – historical epidemiology), allows for the exploration of disease burdens experienced within the population. These records can be used to explore the quantitative incidence of diseases and provide insight into the multifactorial nature of disease causation. Multifactorial is defined as the multiple-factors than can contribute to disease impacts (Hardy, 1994; Ludlow, 2017; Saracci 2007; Zukerman et al., 2014).

In 1943, Kingsley Davis referenced a demographic transition, suggesting that demographically, the growth of the world population is determined by two factors – fertility and mortality and all other factors, whether biological or sociological, result in these (Davis, 1943; Feinleib, 2008; Kirk, 1996). The 'demographic transition,' proposed by Frank Notestein (1945), became an historical depiction-based model specifically from Europe that represents declining mortality in response to growing industrialisation and is regarded as the first definition of the topic (Defo, 2014; Kirk, 1996). The model classifies population growth with regards to *fertility* as the natural capability to produce offspring, and *mortality* as the event of death; both measures are presented as a rate within a population (these terms were first formulated by Warren Thompson in 1929).

To ensure validity of interpretation, studies on mortality and other examinations of population health risks require standardised theoretical approaches that better convey societal interpretations (social, economic, ecological, political factors) (Defo, 2014; Krieger, 2001b;

Ludlow, 2017; McLaren & Hawe, 2005; Mercer, 2014). Historical modelling tools, such as the demographic transition, have been adapted to retrospectively examine the complex health inequalities that are driven by the contextual environment which defines a population (Ludlow, 2014).

The epidemiologic transition model is a necessary component in historical epidemiological studies. The model proposed by Abdel Omran (1971) is an expansion of Notestein's (1945) demographic transition model. It describes fertility and mortality patterns across three transitional ages of disease representing the shift from infectious pandemics to chronic and lifestyle (degenerative) diseases: the age of pestilence and famine, the age of receding pandemics, and the age of degenerative and man-made disease (henceforth more appropriately referred to as human-caused). Application of the model in historical (social) epidemiologic research rests on the following four propositions:

1. Mortality is a fundamental factor and fertility is a significant co-variable.
2. Differential (defining) variables: age, sex, ethnicity, mortality (cause of death).
3. Determinants are defined as eco-biological; socio-economic, political, cultural; and medicine and public health.
4. Varying models are defined as classical/western, accelerated variant of classical model, delayed, and transitional variant of delayed model (Omran, 1971, pp. 733-8).

The first stage, the 'age of pestilence and famine', is defined by three characteristics: mortality rates that correspond with three quarters of deaths being attributable to infectious disease, malnutrition, and maternal complications; less than six per cent of deaths that are attributable to cardiovascular disease and cancer; and life expectancy between 20 to 40 years. The 'age of receding pandemics' is characterised by: epidemics becoming less frequent while mortality rates due to infectious diseases generally start to decline; and a rise life expectancy to 30 to 50 years. The 'age of degenerative and human-caused disease' is defined by four characteristics: a rise in mortality associated with cardiovascular diseases, stroke, diabetes, metabolic disorders, occupational hazards and "stress" related diseases; populations that are generally observed to be succumbing to the effects of lifestyle; fertility, a crucial factor in population growth; and a life expectancy greater than 50 years (Omran, 1971).

The fertility transition, reflects the decline of birth rates from high to low rates over the 19^{th} to the 20^{th} century. The decline and leveling out of both birth and death rates (regional fertility and mortality) contribute to the growth of a society through natural increase. At the beginning of the transition infant mortality is very high and as it declines, it contributes to the decline of fertility as well as overall mortality. The completion of the fertility transition generally occurs in the third epidemiologic transitional 'age of degenerative and human-caused diseases' (McInnis, 2000a; Omran, 1971).

Mortality is a more important indicator compared to fertility which has a biological maximum and minimum and does not fluctuate as much. Fertility is dependent on fecundity, or the ability to produce offspring and how abundantly. Fertility rates occur at high levels early on in the epidemiologic transition and is known to also spike from lower levels following periods of substantial mortality. The decline of fertility generally follows mortality over the course of the transition in terms of the 'classical model.' As life expectancy reaches older ages (e.g. 70 years), after the third 'age of degenerative and human-caused diseases' has been well established, fertility becomes the crucial factor in population growth (Omran, 1983).

The epidemiologic transition model has been expanded by other researchers to include more stages and geographical versions of the overall global transition throughout the ages. The ‘classical’ or ‘western’ transition represents data drawn from England, Wales, and Sweden. A model of ‘delayed transition’ is characterised by Chile and Ceylon (off the south coast of India), while a model of ‘accelerated transition’ is characterised by Japan (Omran, 1983). It was not until about 1920 that the low and middle income populations that represent the delayed version of the model entered the second ‘age of receding pandemics’.

Additional stages applied to Omran’s (1971) epidemiologic transition, include Olshansky and Adult’s (1986) ‘age of delayed degenerative diseases’ which considers the increase of cardiovascular diseases in the 1970s as a fourth age, and a fifth ‘age of emerging infectious diseases’ to incorporate the rising impact of acquired immune deficiency syndrome (AIDS) in the 1980s (Olshansky, Carnes, Rogers & Smith, 1998). These stages are outside the time frame of this study.

An anthropologically-derived explanation of the epidemiologic transition advises that the traditional three ages (pestilence and famine, receding pandemics, and degenerative and human-caused disease) be regarded as a part of an evolutionary framework that follow the agricultural revolution of the Neolithic period and precede the current, modern age of emerging and re-emerging infectious diseases (Zuckerman, at al., 2014).

Aside from different parts of the world experiencing different rates in the development of modern societies as propelled by the industrial revolution, smaller portions of a larger society can experience a notable difference in the rate of development and therefore represent different ages in the epidemiologic transition model (Zuckerman, et al., 2014). When evaluating death records, consideration of more socio-ecological factors can illuminate significant contextual factors specific to the study that might otherwise have been missed. Evaluating such factors are beyond the scope defined in the epidemiologic transition model (Defo, 2014; Krieger, 1994; McLaren & Hawe, 2005; Zuckerman, et al., 2014).

Socio-ecological impacts can be evaluated through examining the variables available in death record datasets that often reflect biological (e.g., age, sex, ethnicity) and socio-economic factors (e.g., culture, occupation, married, religion) (Hardy, 1994; Omran, 1971). These societal features can be the defining factors that exclude a particular group from participating equally in society; resulting in marginalisation or societal inequalities (Bhurga 2014; Ludlow, 2017; McGibbon & McPherson, 2011). An understanding of mortality data that does not consider the history of diseases and societal developments can only be superficially achieved; that is without theoretical, ecological, microbiological, and sociological considerations (McLaren & Hawe, 2005; Mercer, 2014; Omran, 1971; Zukerman et al., 2014). The results of these historical epidemiologic studies however are most importantly defined by the data that is available for analysis.

2.3 Population Growth in North America

Population growth in North America was largely based on immigration. During the early19th century, two events resulted in the increase of immigration to Canada: the Napoleonic Wars (1803-1815) between Britain and France, and the American War for Independence, concluding with the War of 1812 (1812-1815). These events led to interest in agricultural land that was available in Upper and Lower Canada. Loyalists (Americans loyal to the Crown) from the south and immigrants, particularly from Britain and Ireland, were particularly attracted to the prospect of agricultural land due to the favourable terms for which they could acquire it (McInnis, 2000a; Wightman, 1982).

Immigration increased slowly before peaking in 1819; however, documentation of immigrants into 'Canada' was not recorded until 1829 when the first immigration agent was stationed at the port of entry, the Port of Québec. The only records of immigration available prior to 1829 were departure records collected by the Crown in Britain. Evidence suggests that immigration did decline following 1819, likely in accordance with the ban of wheat importation into Britain from 1822 to 1824 (McInnis, 2000a).

It is difficult to distinguish the true impact immigration had on the Canadian region as many migrants moved on to the United States after arriving at the Port of Québec given it was the least costly route into North America. Additionally, despite some increase, immigration declined into the 1830s as it became apparent that agricultural conditions were more favourable to the south. Rebellions also broke out in 1838 between Upper and Lower Canada, further deterring immigration. Despite these challenges, immigration increased again into the 1840s as rural distress spread throughout Ireland and the Scottish Highlands following 1842 with the Irish Potato Famine (McInnis, 2000a; McQuillan, 1985).

The 'great immigration era' had come to an end as immigration declined quickly through the early 1850s and by 1861. Much of this shift was a result of most of the potentially usable land had been claimed and while plans to settle the west were in motion it was not yet a popular option. Following 1861, the Canadian region was impacted by net emigration, as the number leaving was greater than the number arriving (McInnis, 2000a) (See Figure 2.1).

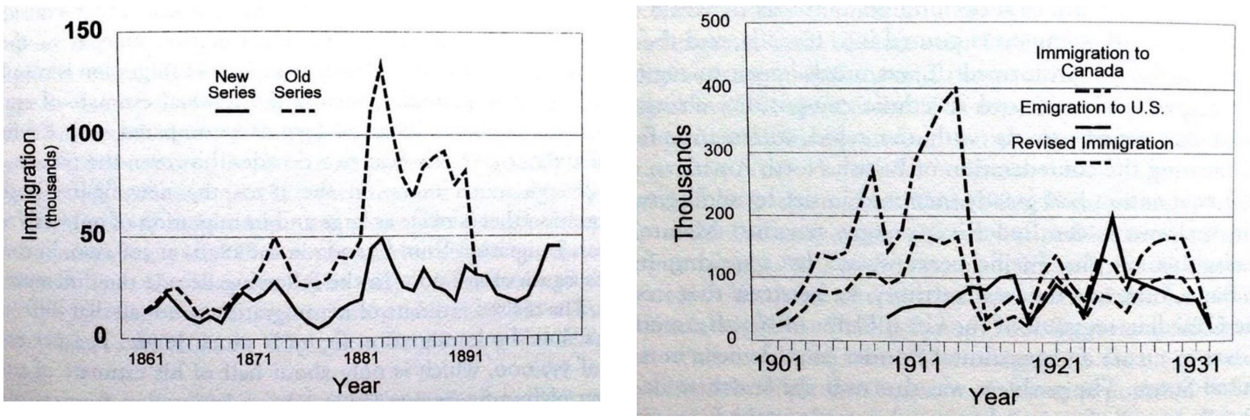

Figure 2.1. Immigration rates. Left: 1861-1900 (McInnis, 2000a, p.423). Solid line reflects the recalculated immigration with all available data. Right: 1901-1931 (McInnis, 2000b, p. 534).

The demographic Peel County History Project (Gagan & Mays, 1973) displays the impact the transition from net immigration to net emigration had on the rural regions of Ontario. The study indicates that the Peel County became an organised settlement following the War of 1812. By 1837 the society had been established and the population was 926. The peak of population growth was in 1841 and the population was 1851. An imminent decline followed and by 1881 the population had decreased to 1363. The high agricultural quality of the southern regions of the province initially made the region a desirable place for settlements. As population growth was largely contributed to by immigrants many regions came to represent communities of like-individuals. Irish immigrants were particularly drawn to Gore of Toronto, one of Peel's smallest townships (Gagan & Mays, 1973).

In the early 20th century there was rapid growth and another increase in immigration leading up to the First World War (1914-1918). The total amount resulting from immigrants arriving in Canada was 2.8% of the average population representing almost triple that of the United States (McInnis, 2000b; 534). This was one of the most pronounced periods of immigration recorded by any one nation. The population grew 20% between 1906 and 1914

(McInnis, 2000b; 537). This growth was largely due to settlement of the western plains which led to increased wheat production (McInnis, 2000b).

Immigration declined some due to the impact of the Great War (WWI) followed by the Spanish influenza pandemic (1918-1919). During the period following, the 1920s, emigration to the United States was larger than total immigration to Canada. However, immigration would increase again leading up to the 1930s. At the beginning of the century there were 11 major settlements (1901 census) which rose to 26 major settlements by 1931; major settlements were defined as having a population of 25 000 or more (McInnis, 2000b; 560). The largest cities, both ports were Montreal, the banking center and Toronto, the commercial center. Post 1900, Toronto grew more rapidly as did Ontario as a whole (McInnis, 2000a; McInnis, 2000b).

The slowest period of growth was during the 'great depression' in the 1930s. Rates of unemployment were even more severe in the United States and not many migrated or immigrated. During this period, the fertility transition ended (with the rate over time remaining relatively constant) as well as a significant decline in infant mortality and the overall mortality rate (McInnis, 2000b). Population loss and emigration throughout 1861 to 1901 evened out between 1901 and 1921 (McQuillan, 1985).

Some regions of Canada were settled later, in the latter part of the 19^{th} century. Declines in fertility rates, in particular, in these smaller more rural regions (e.g. Huron and Perth in Ontario) dropped (or transitioned) more quickly owing to a period of initial adaption, before falling in line with the decline consistent with the rest of the province into the 20^{th} century (McInnis, 2000a).

For 1861 to 1931, the period consistent with this study, population data for Indigenous people are more difficult to trace, as little attempt has been made to determine rates and investigate population totals for this group (McInnis, 2000a). As such, it is inappropriate to determine any sort of statistical interpretations. However, the registration of Indigenous people did begin on Manitoulin Island prior to Confederation, and the population counts are displayed in Table 2.1. Some years do not have counts, the reason for this is unknown (Wighman, 1982).

Table 2.1

Indigenous Population on Manitoulin Island

Year	*N*	Year	*N*	Year	*N*
1835	*70*	1844	*783*	1853	*1330*
1836	-	1845	-	1854	*1293*
1837	*268*	1846	*1027*	1855	-
1838	*307*	1847	*1089*	1856	-
1839	*655*	1848	-	1857	*1356*
1840	*732*	1849	*1248*	1858	*1290*
1841	-	1850	*1294*	1859	-
1842	*702*	1851	*1332*	1860	*1364*
1843	*764*	1852	*1322*	1864	*c.1350*

(Wightman, 1982; 21) (-) Population counts, not available.

2.3.1 The Epidemiologic Transition in North America

Completeness of mortality data in Canada was very poor especially prior to 1900 and even leading up to 1921. However, in terms of representation of the population, data on infant mortality was more accurate and reliable than that for both single young adult and elderly mortality (McInnis, 2000a; McInnis, 2000b). Infant mortality rates are necessary in order to calculate fertility rates; however, these data are also considered somewhat complicated prior to the end of the 19th century. This is due to the quality of census returns and the collection and evaluation of vital statistics prior to 1931, and especially prior to 1901 (McInnis, 2000a).

During the 19th century, there was substantial migration to North America from England, Scotland, and Ireland as well as between Canada and the United States. The latter half of the 19th century saw out-migration as economic opportunities increased on the American Frontier. This movement of people contributed to an economic depression that began around 1873. The Canadian economy remained depressed up until 1896 (McInnis, 2000a), despite growing economies such as the region of Georgian Bay and Manitoulin Island, Ontario (Barkin & Gentles, 1990; Gagan & Mays, 1973; Pearen, 2012; Wightman, 1982). Population growth was slow during this depressed period (1873-1896) (McInnis, 2000a).

The epidemiological transition for the United States is identified as aligning with the 'classical transition' as described by Omran (1983). In comparison to the European data that corresponds with the 'classical transition', the United States had somewhat higher rates of fertility that were slower to decline. New York, from 1804 to beyond the 1920s, is described as having almost a complete passage through the epidemiologic transition ages: 'age of pestilence and famine' (1804-1853), the 'age of receding pandemics' (mid-19th century to the 1920s); and the 'age of degenerative, human-caused diseases' (the years following the 1920s) (Omran, 1971; Omran, 1977).

Mortality rates probably first began to decline mid-19th century for the 'white' or affluent populations. Fertility rates were extremely high at this time and did not begin to fully decline until the 1920s in Canada (Barkin & Gentles, 1990; McInnis, 20001b; Omran, 1977). The period of industrial change began in mid-18th century Britain, and spread to other countries, taking effect in Canada in the late 19th and early 20th centuries (Ludlow, 2017). In Ontario, the transition of decreasing fertility rates from 1861 to 1931 is unusual as it was more of a rural phenomenon than an urban one. That is, the fertility rate dropped within the countryside before it did in the cities (McInnis, 2000a).

The most notable gap was apparent in the fertility rates between Anglophones (English-speakers) and Francophones (French-speakers) in the 1891 census (McInnis, 2000a; Pelletier, Légaré, & Bourbeau, 1997). Anglophones had low fertility by 1891, and some rural regions in Ontario (e.g., Grenville South: 79 per 1000 and Dundas: 84 per thousand) had recorded some of the lowest infant mortality rates in the world (McInnis, 2000a:405). Infant survival for Anglophones was 115 versus 190 (per thousand) for Francophones in the 1891 census (McInnis, 2000a; 404). In 1901, infant mortality for Ontario was estimated as 117 per thousand, and 139 for Canada. The decline continued and in 1931 the rate in Ontario was 86 per thousand. Given low fertility rates in rural Ontario, lower infant mortality would have been a direct result in this decline (McInnis, 2000b)

Aside from the impact of immigration, Canada grew mainly through natural increase (births and deaths). The mortality rate, however is more difficult to decipher as data are fragmented leading up to the 1921 census. Remote, or outlying areas routinely had defective returns of census enumeration data and the collection of population counts by age and defined districts (which during this period of transition were changing), again, were not uniform as the methods for enumeration had not yet been well established. This combined with the under reporting of deaths makes calculation of the death rate difficult (McInnis, 2000b).

The crude death rate estimate for Canada in 1901 is 14.4 and likely under represents the reality (McInnis, 2000b). In 1901, infectious diseases were still quite prominent. It seems that Canada had a higher death rate than the United States due to tuberculosis, but it is likely some deaths may have been misdiagnosed and were actually the result of pneumonia or influenza, or other respiratory complications. Overall, the impact of tuberculosis on the death rate in Canada was likely lower than the United States (McInnis, 2000b). It is important to note that in 1901, Canada's population was only 7% of the size of the United States population (McInnis, 2000b:530).

In Ontario, mortality rates improved gradually, but not steadily between 1861 and 1921. From 1861 to 1920, rates were more consistently below the national average and significantly lower than Québec (McInnis, 2000a; McInnis, 2000b; McQuillan, 1985; Pelletier, Légaré, & Bourbeau, 1997). Despite European populations (with United States not far behind) being considered to have entered into the second age during the 19th century in Canada, *crisis mortality* (a mortality rate that far exceeds expectation) continued into the 20th century and only really dissipated after the 1918-19 Spanish influenza pandemic (Omran, 1977; Zuckerman, et al., 2014). This pattern was driven by the impacts of migration that led to environments which caused outbreaks in infectious disease as well as being spread by the dispersal of soldiers returning home from war (Pepperell, et al., 2011).

An analysis of 24,124 deaths from a Victorian cemetery in Toronto (1850-1899) conducted by Barkin and Gentles (1990) reveals that the region experienced very high rates of mortality, of which over 40% accounted for infant mortality. These rates are described as "shockingly" high, and exceed rates demonstrated in England and Wales in the 16th to 18th centuries. The leading cause of adult death was tuberculosis. Mid-century, females were 8% more likely than males to die of tuberculosis, but by the 1880s it had become much more common among males. The death rate in 1866 was reported as 26.2 per thousand; however, in 1897, the rate had shrunk to 15.1 per thousand, lower than the death rates for Boston and New

York. In 1868, Toronto, surviving to the age of five, meant living to the age of about 40.3 was promising. This life expectancy rose to 52.1 years by 1898 (Barkin & Gentles, 1990).

Reductions in infant mortality contribute to the most substantial increases in life expectancy as populations transition between the second epidemiologic ‘age of receding pandemics’ and the third ‘age of degenerative, human-caused diseases.’ A high rate of reproduction followed immigrant settlement in Canada contributing to growth through natural increase (McInnis, 2000a:388). Mortality was generally higher in the cities with Québec; Montreal and Quebec City were considered unhealthier than cities in Ontario during the 19th century (Pelletier, Légaré, & Bourbeau, 1997). Life expectancy did not truly increase until the substantial decline in infant mortality leading up to the 1920s. By 1921, life expectancy in Canada had for the most part evened out between the sexes and was recorded at 57.0 years (Bourbeau & Ouellette, 2016; Canadian Human Mortality Database, 2014).

2.3.2 Improvements to Public Health

Thomas McKeown (1976) theorises that over the past two centuries the modern rise of population and dramatic reductions in mortality were not due to medical and public health interventions but rather the improvement of socioeconomic conditions. He argues that medicine did not play a key role until the introduction of penicillin in the 1940s (Link & Phelan, 2002; McKeown, 1976; McLaren & Hawe, 2005; Mercer, 2014).

McKeown’s hypothesis has been widely disputed on the basis of political biases, smallpox inoculations, vaccinations and quarantine, improvements in milk quality, the development of hospitals, and other curative measures as causes for the improvement in health (Colgrove, 2002; Harris, 2004; Mercer, 2014; Schofield & Wrigley, 1981; Szreter, 1988). In Toronto, calomel was still being used to treat diphtheria in 1891 and milk pasteurization was not regulated until 1918, by which time there had already been a dramatic reduction in mortality (Barkin & Gentles, 1990). In Canada the most notable difference in factors that impacted infant survival was between Anglophones (English-speakers) and Francophones (French-speakers). Anglophones more commonly breast-fed, while Francophones more commonly bottle-fed, the latter more likely to exposure their child to unsanitary milk (McInnis, 2000b).

Sulphonamides and antibiotics, and relatively safer surgical procedures did not become widespread until the 1940s (McInnis, 2000b). Thus the rise in age at death throughout the second half of the 19th century was likely a result of improvements in preventative public health measures such as nutrition, rather than developments in medicine (Barkin & Gentles, 1990).

Schofield and Wrigley (1981) suggest growth in population was due to a decline in mortality, not a rise in fertility. Simon Szreter (1988) re-ran the analysis of McKeown's study and determined the death records to be misinterpreted, disagreeing with his proposed "rising standards of living" as too broad of a statement, and was more in favour of medical interventions including public investment in health, and education that fueled the changes in human (health) development (Colgrove, 2002; Harris, 2004; Mercer, 2014).

This disagreement with McKeown's thesis asserts that the role of social conditions is insignificant and would leave questions regarding how social factors in health affect epidemiology. Those in agreement with McKeown argue that populations develop the means to avoid disease and death through knowledge, money, power, prestige, and beneficial social connections; and the accessibility or control of these variables are shaped by socioeconomic resources that are enhanced by health directed human agency (Grattan & Torrence, 2003; Link & Phelan, 2002; Mercer, 2014).

Knowledge of diseases increased with the 1880s Germ Theory that revealed the exposure of microbial exacerbation in unsanitary or unhygienic environments. The theory led to advancements in public health measures and sanitation (Bhurga, 2014; Dobson, 2013). Unsanitary and unhygienic environments would persist, particularly in urban locations, with the transition of the industrial revolution in North America. Environments such as those influenced by overcrowding, poor water quality, poor food handling, poor housing and infrastructure, and inadequate sewage, produces excessive disease burden. Diseases like cholera, typhoid, and tuberculosis were exaggerated by these environmental conditions and were exacerbated though malnutrition and weakened immune systems. These diseases spread rampantly through urban centers and the working class (Ludlow, 2017).

This period in the transition follows the devastation of the First World War, an act of political violence that caused a cascade of societal impacts. Following periods of war, with the return home of soldiers, it is common for populations to experience an increase in deaths due to infectious diseases and suicides, a disruption in familial systems, and an increase in community-level violence enhanced by alcohol. These are only just a few impacts at the community-level resulting from rapid social change caused by war (Krug, Dahlberg, Mercy, Zwi & Lozano, 2002).

2.4 Contextual Environments

2.4.1 Applications of Ecology

Historical research into health impacts can provide insight into the multifaceted pathways of health inequalities. These inequalities relate to the social and economic conditions of the overall society (Currie, et al., 2008; Ludlow, 2017). Research within the field of ecology emphasises the importance of localisation or landscape, a specific understanding of complex factors in relation to the boundaries of the context and the interaction between living organisms and their environment (McLaren & Hawe, 2005). A sub-field of biology, ecology is versatile in research application and as a result represents a spectrum of explicit concepts. One end of the spectrum is reflected in the concept of *landscape ecology* and incorporates the idea that humans do not influence the environment. *Historical ecology* represents the other end of the spectrum and incorporates humans as the principle mechanism of change or keystone species (Balée & Erickson, 2006).

Considering historical ecology is important in research that reviews economic aspects in relation to population disease patterns. The boundaries of the contextual landscape define the intersections between society and individual experience that may increase susceptibility to certain disease pathways (e.g. unemployment leads to not being able to provide adequate nourishment which leads to a weakened immune system) (Balée & Erickson, 2006; Krieger, 2001a; Krieger, 2001b; Mercer, 2014).

The theoretical concept of *intersection* is used to understand health as patterns of relations rather than as a quantitative outcomes (Bauer; 2014; McLaren & Hawe, 2005). The concept of intersectionality was first developed within the context of feminism to address racial discourse experienced by women of African descent (Crenshaw, 1989). Since then, its application has grown to encompass the interpretation of what is termed the "isms." The intersections of identity classifications such as age, culture, (dis)ability, gender, and ethnicity impact societal opportunities, creating marginalisation and oppression through classism, sexism, ableism, racism, and so forth (Bauer, 2014; McGibbon & McPherson, 2011; Navarro, 2007).

Intersection is a simple tool applicable to the deconstruction of multifactorial disease pathways and can be easily used to consider the interplay of contextual environments.

Exploration of disease pathways and how they intersect with the environmental context can reveal "who and what is responsible for population patterns of health, disease, and wellbeing, as manifested in present, past and changing social inequalities of health," (Krieger, 2001a, p. 668). Krieger's work explores morbidity and mortality with a considerably larger focus on lifestyle factors compared to the epidemiologic transition (social, economic, political) (Krieger, 1994; Krieger, 2001q; Krieger, 2001b).

Some contextual environments are moulded by historical circumstances that are more dramatic in altering the environment (Colgrovo, 2002; Dewalts & Pincus, 2003; Krieger, 2001a, Krieger, 2001b; Walters & Simoni, 2002). Often times, exploring data from past populations can offer insightful perspectives into impacts of diseases by their observable trends. Diseases and social factors are not seen as existing in isolation, but in an ever-changing web of individual intersections (Bhurga, 2014; McGibbon & McPherson, 2011).

Any analysis conducted on data relating to population health should consider social structures. In particular, studies that are investigating chronic conditions should particularly consider social applications in the analysis process. This means research must go beyond application of typical methods in order to address the individuality of different regions and how the contextually-related environment may have led to pathways of disease causation (Defo, 2014; Mackenbach, 1994; Mercer, 2016).

There are various classification systems for defining different aspects of society (Lambertt & McKevitt, 2002), as well as models and frameworks that attempt to encompass the fluidity of these different aspects of research applications (McLaren & Hawe, 2005). Such systems for defining aspects of society are conceptualised across many disciplines, with Anthropology and Sociology taking a particular interest. Definitions of social class are founded in the Weberian system and in Karl Marx's work (Carson, Dunbar, Chenhall & Bailie, 2007; Evans, 2009). Similar classification systems have been developed to differentiate other societal aspects, but are limiting and sometimes discriminating in categorisation (Bauer, 2014; Bronfenbrenner, 1994; Liberatos, Link & Kelsey, 1988; Lomas, 1998; Navarro, 2008; Wiley & Allen, 2013). Cultural behaviours are embedded within this context and relate to disease experiences and the development of knowledge (Balée & Erickson, 2006; Krieger, 2001a; Krieger, 2001b).

Models and frameworks that explore cause of death trends employ epidemiological perspectives (e.g. Omran's (1971) epidemiologic transition). These models and frameworks are explicitly used to understand the multiple dimensions of health and disease (multifactorial causation), which is an increasingly complex process. The validity of the results are often dependent on the methods and actions of the reviewer. Populations experience shifts in social development brought on by economic shifts at different times and in different locations. It is often difficult to access and interpret the socioecological perspectives that contribute to a more complete understanding of disease impacts on a region (Defo, 2014; Hardy, 1994; Krieger, 2001*a*; Krieger, 2001*b*; Mercer, 2014).

The ecological aspect of the land in combination with the societal implications of the developed environment predisposes societies towards various developmental trajectories, as the physical environment can define societal advancements. Experience with disease and resulting human behavioural responses can be compared to how the impacts of natural disasters are understood (Bhurga, 2014; Grattan & Torrence, 2003). The severity of natural disasters can be assessed based on duration and frequency, a society's familiarity with risks, their ability to adapt and recover following the disaster, and the degree to which the events disrupt the social order.

Disasters can be either rapid, a noticeable onset of events (e.g., tornado), or a slow onset of less noticeable events (e.g., climate change) (Grattan & Torrence, 2003). Extreme events induce a cultural change as perception of an event becomes the determining factor in the ability to recover, to adapt and find stability. Reactions to the forcing mechanisms are key factors within the process of societal developments and ultimately the defining vulnerability that influences the likelihood of disease.

The multi-level eco-epidemiological life course framework (Defo, 2014) provides a comprehensive, anthropologically driven model that explores and summarises disease pathways by building upon a number of other models and theories. On its own, it is a new evidence-based model that focuses on the multifactorial pathways and varying levels of impact, which define a breakdown of health-related intersections (see Figure 2.2), bringing together epidemiological and crucial ecological perspectives into the analysis of population health (Defo, 2014).

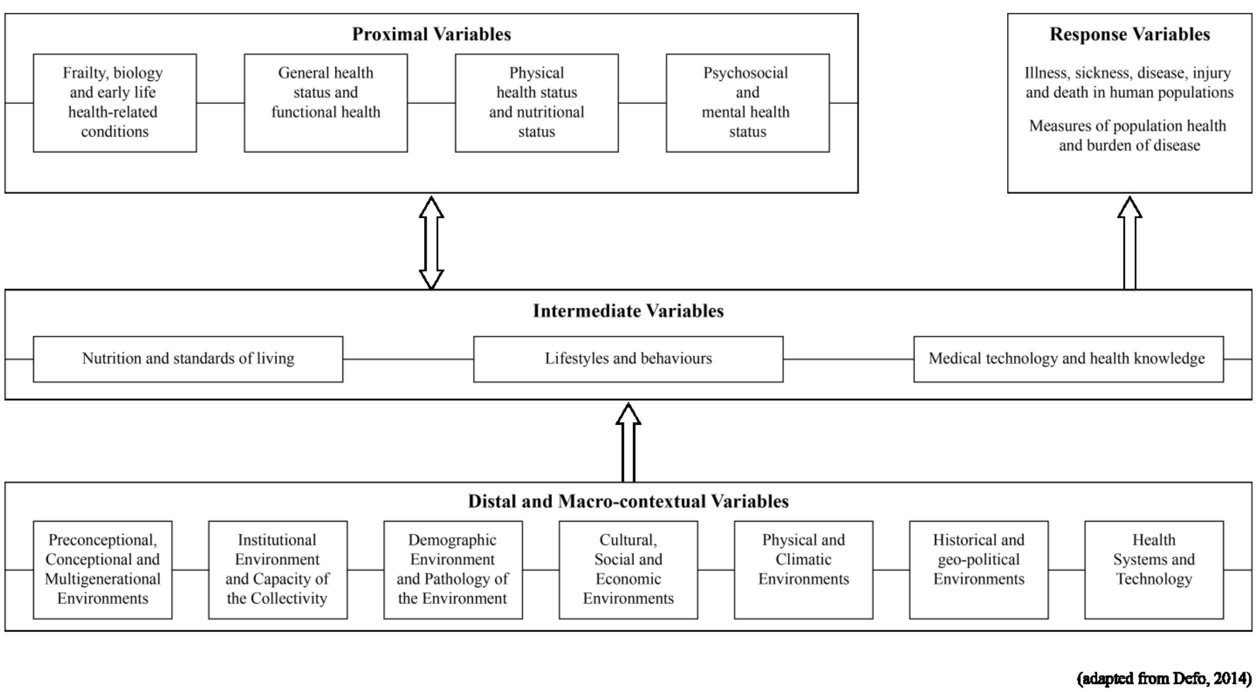

Figure 2.2. The multi-level eco-epidemiological life course framework.

Defo's (2014) framework helps to understand and interpret impacts on disease (or the pathways of disease causation) at micro to macro levels. It conveys which contextually-defined environments may impact societal interplay and to what degree, while considering: interacting societal interplay, enduring norms and rules, organisation of networks and culture, child rearing and medical practices, conceptualisation of surroundings and world views, and social positions and relevant collective goods – all defined by the context of the region (Defo, 2014). The *distal and macro-contextual variables* in Figure 2.2 reflect comprehensible categorisation of the complex driving forces embodied in the developing nature of human beings and therefore health outcomes (Bhurga, 2014; Evans, 2006).

In health and disease research, the classification of diseases is particularly important. According to Bhurga (2014), poor health can be classified into three perspectives: disease, sickness, and illness. 'Disease' is the medical classification and diagnosis of physical and mental conditions based on accumulated knowledge. 'Sickness' represents the societal expectations held in relation to disease, such as how one is expected to act in relation to symptoms, available medical care, and the terminology used. 'Illness' is the individual experience of disease in relation to social functioning (Bhurga, 2014).

The concept of infectious and degenerative, non-communicable disease maintained by the epidemiologic transition, classifies complex disease systems as simple dichotomies. Infectious complications are usually associated with short term (acute) impacts while degenerative, non-communicable complications are usually associated with long term (chronic) impacts. The roles infection and inflammation play in the human body over time are not completely understood and therefore not as easily categorised (Mercer, 2014; Zukerman et al., 2014).

According to Mercer (2014, 2016), the following disease pathways complicate the differentiation between 'infectious' and 'degenerative': childhood acute respiratory infections that can develop into arrhythmia; childhood exposure to measles, typhoid, or rheumatic fever (infectious) that can develop into chronic respiratory or valvular diseases, not limited to arrhythmia, congestive heart failure, and muscular-skeletal conditions in adulthood; and childhood diarrheal diseases and malaria that can develop into arteriosclerosis (hardening of the arteries) and joint conditions in adulthood.

As previously mentioned, multifactorial disease causation makes comprehending cause-specific historical deaths a complex process. More recent understandings regarding the historical and evolutionary relationships between humans and pathogens have confused our understanding of disease processes further. Particular influences on non-specific cerebrovascular and cardiovascular complications are not yet sufficiently understood, while less common disease categories are more prone to distortion (Mercer, 2014; Mercer, 2016).

2.4.3 Understanding Major Disease Pathways

Historical death records can reveal and be used to explore prominent and easier-to-diagnose causes of death, specific to the region and time period. Throughout the Colonial era, disease was spread globally through continuous contact and migration of groups of people exhibiting different profiles of disease exposure. With little opportunity to become familiar with the hazards of expansion, colonialism was a chronic threat that would become a part of culture (Balée & Erickson, 2006; Grattan & Torrence, 2003; Maar, Sutherland & McGregor, 2013).

Generally, major killers of the end of the Colonial era which coincided with the latter half of the 19^{th} century in North America included cholera, tuberculosis, smallpox, and numerous non-specific causes, many linked to poor living conditions (Dobson, 2013). The major childhood killers were diphtheria, scarlet fever, measles, meningitis, and whooping cough (Mercer, 2014). In 1875, one quarter of all deaths was infantile and the expected lifespan was 43 years for most developed parts of the world (Omran, 1971). Respiratory infections, particularly tuberculosis was the leading causes of death for neonatal and postnatal mortality followed by cholera caused by the ingestion of fecal matter. Cholera and typhus were most common cause of childhood mortality as well as acute infections, all of which were exacerbated by malnutrition (Aber, Bennett, Conley & Li, 1997; Higgins, 2003; Lawn, Cousens, Zupan & Lancet Neonatal Survival Sterring Team, 2005; Sawchuck & Burke, 2003).

Tuberculosis, a transmissible bacterial infection of the respiratory tract is defined as an infectious disease that has the capability to lay dormant for a period of time only to become apparent during periods of stress on the respiratory system (e.g., other infections, poor nutrition, and old age). Over time, it has developed resistance to available treatments. Tuberculosis can also be contracted through ingestion of contaminated products such as cow's milk (Mercer, 2014).

Population movements were associated with the high incidence and spread of tuberculosis throughout the Colonial Era. Eventual decline of the disease corresponded with an increase in other respiratory diseases in the second half of the 19th century (bronchitis and pneumonia) (Pepperell, et al., 2001). Pulmonary tuberculosis, a highly contagious disease, was spread extensively throughout this period. Many elements can exacerbate its impact such as overcrowding, and other respiratory infections which increases vulnerability to it. (King, Smith & Gracey, 2009; Long, Njoo & Hershfield, 1999; Pepperell, et al., 2011; Young, 1988).

A rapid increase in diabetes was recorded in late 19th century North America, attributed to rapid social and dietary changes (Dobson, 2013; Tjepkema, 2002; Valenti, 2016). This increase was largely representative of Type 2 diabetes mellitus that was generally developed later in life, as a result of the body's increasing resistance to insulin. Type 1 in comparison is the inability of the pancreas to ever produce insulin. Type 2 diabetes mellitus has particularly impacted Indigenous communities on Manitoulin Island (Maar, Manitowabi, Gzik, McGregor & Corbiere, 2011; Waldram, Herring & Young, 2007). While it was considered rare outside Europe until the early 20th century, this may have been due to a lack of evidence as diabetes presents with a number of secondary complications (Nwaneri, 2015; O'Donnell, 2015) such as heart disease, stroke, chronic kidney disease, foot ulcers, and brain damage (WHO, 2013).

Cancer, like cardiovascular disease, and diabetes, is the result of multifactorial causation, and can impact the entire body. Well known risk factors of cancer result largely from lifestyle factors: genetics, alcohol, obesity, smoking, etc. (Forouzanfar, et al., 2016). Cancer, or malignant tumors, has been documented since Ancient Egypt (Dobson, 2013); malignant cell growth was not historically uncommon. Populations however did not live long enough to die of its chronic complications as they were impacted more so by infectious outbreaks. Thus, cancer deaths have commonly been associated with the more modern era, or the 'age of degenerative, human-caused diseases' (Mercer, 2014; Omran, 1971; Zuckerman, et al., 2014).

Crisis mortality is considered not to have dissipated until following the 1918-9 Spanish, influenza pandemic (Zuckerman, et al., 2014). In "western countries" an influenza pandemic also occurred in the early 1890s. Death were attributable to a number causes including cardiovascular conditions, bronchitis, pneumonia, and influenza. It is suggested that seasonal influenza can cause acute myocardial infraction deaths as well (Mercer, 2016).

2.4.4 Reflection on Manitoulin Vulnerability

As the 19th century transitioned into the 20th century, Manitoulin Island experienced rapid migration (Pearen, 2001; Pearen 2012). When the original occupants of a location experience rapid migration, they are at first more vulnerable to greater health inequalities, through marginalisation, as they become exposed to diseases and changes to which they are not able to quickly adjust; at the same time, incoming populations have less resources to support themselves due to the move and exposure to new physical environmental risks (Aber et al., 1997; Bronfenbrenner, 1994; Kanaiaupuni & Donato, 1999). In this case, without the aid of the Indigenous People on the island to teach new settlers to hunt, clear land, and navigate the island environment, the settlers were more likely to perish in their first winter due to the harsh environment (Derry, 2010). Environmental knowledge, key to survival, is contingent on interaction with people and experience over time in the particular landscape (Balée & Erickson, 2006).

Early 20th century, doctors on Manitoulin Island were skilled at procedure, but lacked knowledge (McQuarrie, 2006; Wightman, 1982). Appendectomies were common surgeries, but few knew how to treat a stroke. Accidents were also common in the isolated and often harsh environment. Amputation was a common and likely solution to many ailments such as broken limbs or frostbite. Doctors made house calls, performed surgeries on kitchen tables by the light of a coal oil lamp, and surgical tools were disinfected with hot water and alcohol (McQuarrie, 2006;87). They worked alone and sometimes had to travel over a day in a winter storm to reach an isolated patient. When a hospital was opened in Mindemoya in 1919, home surgeries were not entirely discontinued. Up until that point the nearest hospitals were in Sudbury, Sault Ste. Marie and Toronto (McQuarrie, 2006).

Neonatal mortality rates were indicative of the health of a population. Infant mortality was highest in the first 24 hours due to congenital complications and deaths due to circulation issues, convulsions, and other non-specific causes (Mercer, 2014). Midwives performed the delivery of infants at home and a doctor would later make a house call to check in (Derry, 2010). Later on, mortality could have been due to conditions such as tetanus, pneumonia, diarrhea, asphyxiation, and congenital abnormalities. Maternal age and health were the defining factors in birth weight and carrying to term (Mercer, 2014). Prenatal and postnatal nutrition were also major risk factors in both birth weight and carrying to term, as well as later life risk factors such as a lower immunity (Mercer, 2014). Poor postnatal health could lead to increased vulnerability to infectious disease bouts throughout the life course, especially during periods of decreased food availability (Lawn et al., 2005; Mercer, 2014; Walker & Johnson; 2003). On Manitoulin Island, little could be done for sick infants (Derry, 2010).

Farmers generally worked alone and were prone to accidents such as falls, and injuries from farm animals and equipment. Logging camps, however, are described as providing a difficult but healthy lifestyle for the labourers. Lice were common, but disease and injury were not common in logging camps (Derry, 2010). Death due to physical injury caused by an accident was a prominent cause of death listed in the 1891 census (McInnis, 2000a).

Steamers were the common form of transportation when the water was not frozen. They provided accessibility to the island during the warmer months but were known to catch fire and sink, or capsize in heavy waters. The Mississagi Strait between Cockburn and Manitoulin Islands was considered a particularly dangerous passage that claimed many boats. Fires were a common threat to the island's inhabitants who worked with timber and the region was prone to forest fires. Wooden buildings were heated with stoves that burned wood, adding to the risk. These were major risks for fires and resulting economic output. One such incident occurred in Little Current in 1919 when a huge fire destroyed many businesses (McQuarrie, 2006). Exposure to the elements was also a serious concern during the winter, especially when travelling over ice. The latter, in particular, required specific knowledge about the terrain to execute such a task safely (Derry, 2010; Pearen, 2001).

2.5 Contextual Landscape: Manitoulin Island

2.5.1 Introduction

Manitoulin Island, located at the north end of Lake Huron is considered relatively isolated. *Ekaentoton* was the first recorded name given to Manitoulin Island by the Huron. It means "where there are many things washed up and littering the shore." The Algonquians called the island "Manitoulain," a slang of Manitowaning (Den of the Spirit or Manito's Den) (Putnam, 1947; Pearen, 2012). The island has several other names and variations: Manitoulin, The Isle of a Hundred Lakes; *Maneetoolin* (Ojibwae for Spirit Island); *Odawa Minising* (Isle of the Odawas or Island of the Ottawas), and *Mindoo Minising* (Island of Manitou) (Pearen, 2012). The first inhabitants of Manitoulin Island were the Algonquian linguistic groups, Odawa, Ojibwe (*Anishinaabe)*, and Potawatomi (Greene, 2005; Pearen, 2012; Pearen 2001; Wright, 1981). The *Anishinaabe* believe that Manitoulin Island was a gift from the Creator, *Kitchi Manitou*. Odawa *ogimaa* (chief) Assiginack (later Jean-Baptiste Assiginack) declared that the island was the actual site of creation and the creator had placed the Odawa people there, *Odawa Minising* (Corbiere, 2012) (see Figure 2.3).

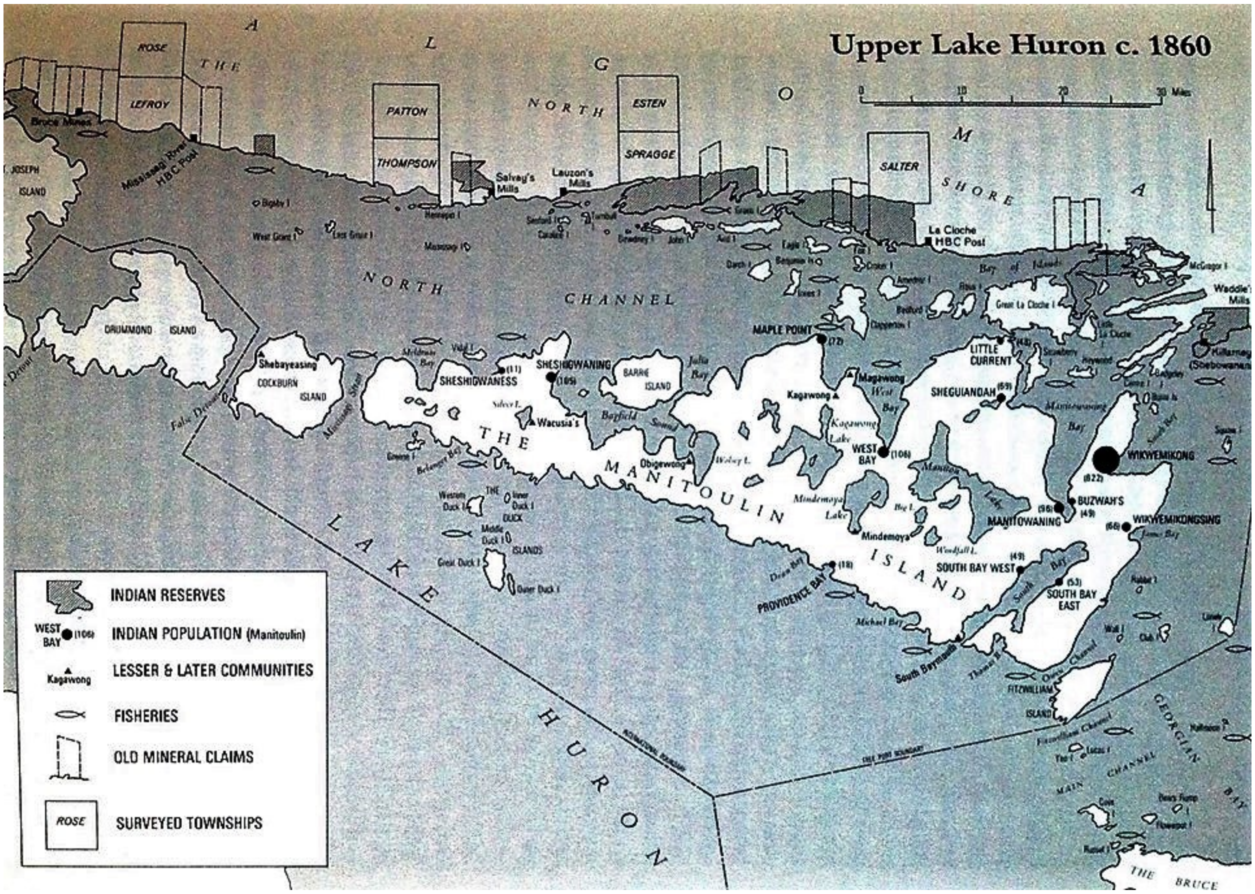

Figure 2.3. Map of Manitoulin Island in 1860 (Wright, 1982, p. 41).

2.5.2 Physical Description

The island is 4411 square kilometers in size and is the largest fresh water island in the world. The biggest urban center nearby, Sudbury, is one hundred and sixty kilometers away. On the island, Little Current is the largest settlement, located within the township of Howland. Today the island has 16 townships including 12 municipal organizations, four unorganized, and six Indigenous reserves (see Figure 2.4). The first census, conducted in 1871, organized the island in three townships, *Manitoulin*: *West*, *Center*, and *East*. By 1881, the Island was considered to be under the *Algoma East* district and included the townships: Assiginack, Howland, Bidwell, Sandfield, Tehkummah, Carnarvon, Billings, Campbell, Allan, Gordon, Mills, Burpee, Barrie Island, Robinson, Dawson, Cockburn Island, and Duck Island (Wightman, 1982).

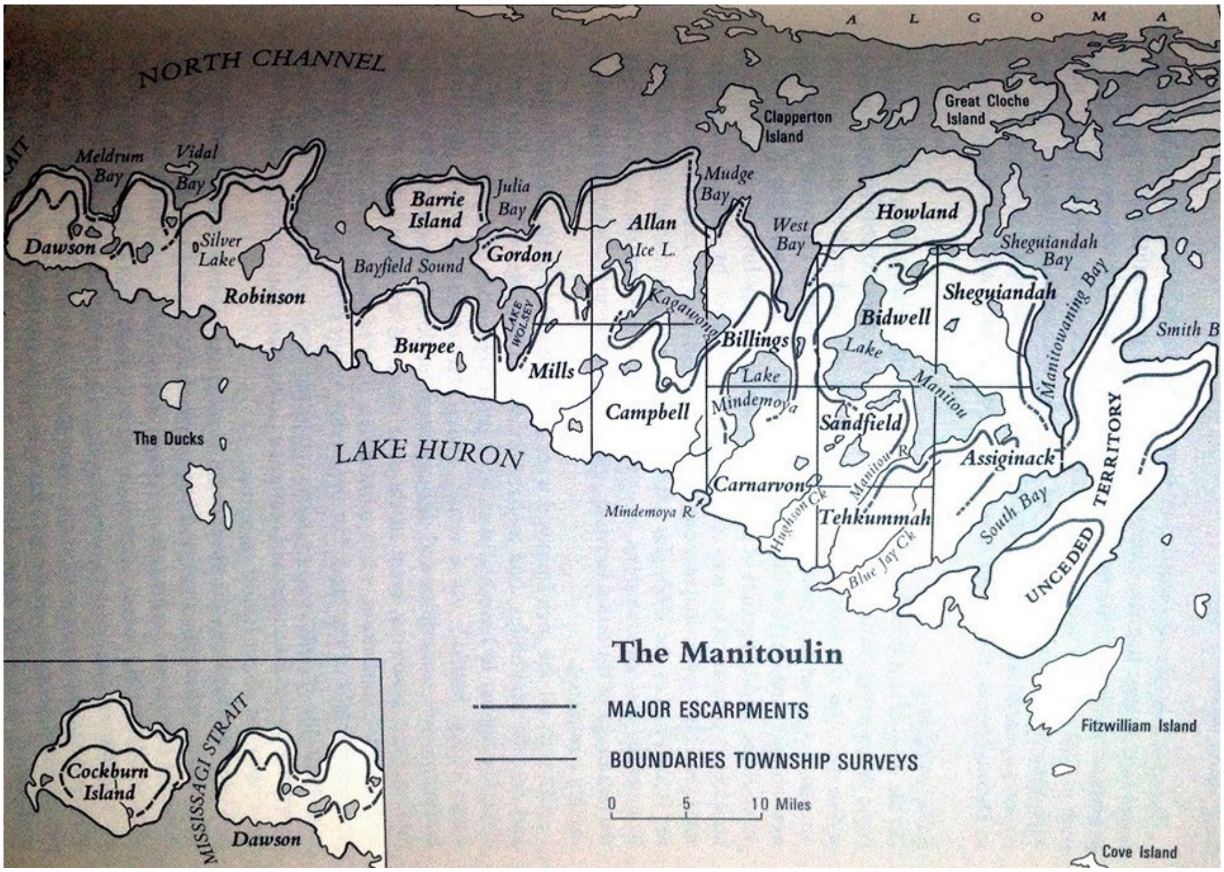

Figure 2.4. Map of Manitoulin Island with divisions (Wright, 1982, p. 61).

The island's geomorphology is a part of the Precambrian shield, made up of igneous rock, limestone and dolostone (Kraus, Henson & Ewert, 2009). The limestone and dolomite formed ~450 mya during the Silutian and Ordovician periods of the Paleozoic era within an equatorial ocean, hence the good quality arable land. The island's west end is largely dominated by karst land formations (Enyedy-Goldner, 1994). This formation results in alvar type habitats, which are open, rocky terrains that have no soil or only a thin covering and thus a high solar exposure. Alvars are subject to flooding in the spring and fall and drought in the summer. These habitats often produce more diverse ecosystems and are globally rare (Catling & Brownell, 1995; McQuay, 2013; Wight, 1981).

Consistent with the island’s geomorphology, is the dispersion of hardwood forests, evergreen forests, marshes, sandy and rocky beaches. The older layer of limestone formed during the Ordivican period covers the north and north-east portion of the Island. The bluffs in this region that slope towards the north shore were formed during the Silurian period (McQuay, 2013; Pearen, 2001; Wightman, 1982).

The newer layer of dolostone formed during the Silurian period over the limestone in the south shore portion. The hardwood forests found here contain thin soils and are littered with marine fossils. Trees such as maple, oak, beach, birch, and ironwood grow in these forests. Evergreen forests and marshes are found along the south shore (e.g. South Baymouth, Tehkummah). The large boulders found on the south shore in Misery Bay, Burpee and Robinson, are reminders from the last glacial period, beginning about 110 000 years ago, and the retreat of the Wisconsin glacier resulting in the Canadian Shield (McQuay, 2013; Pearen, 2001) (see Figure 2.).

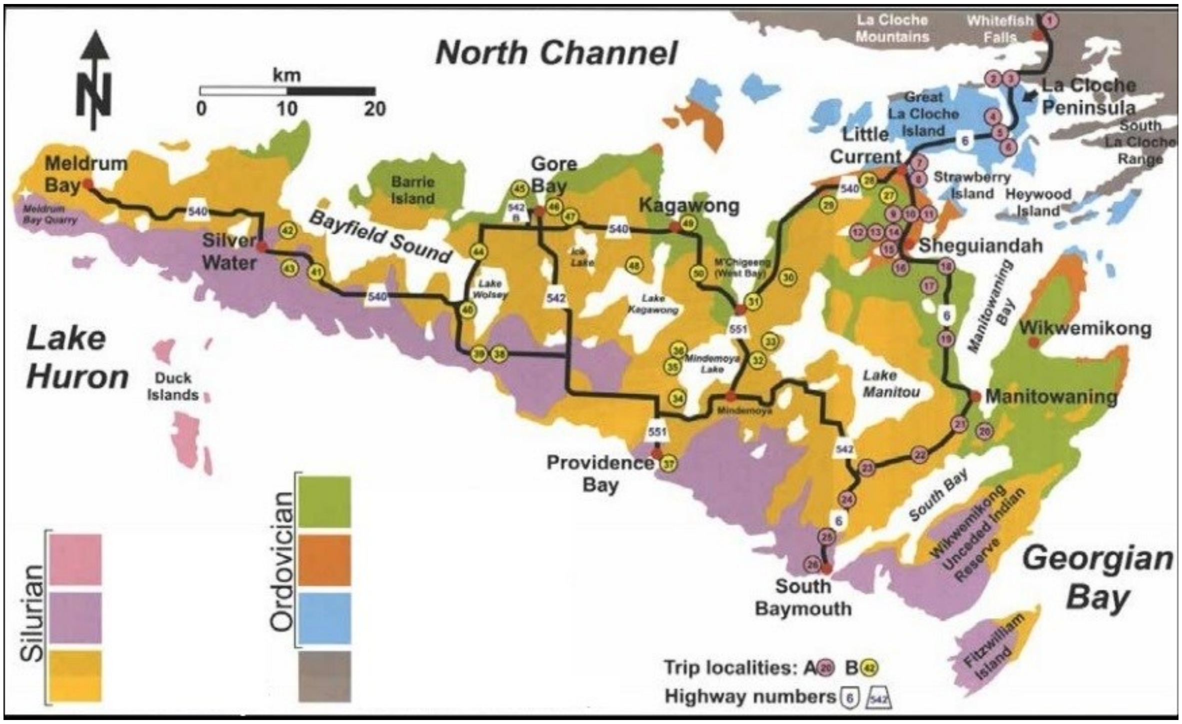

Figure 2.5. Rock distribution across Manitoulin Island (adapted from Conigilo, Karrow & Russell., 2006).

Manitoulin is greatly affected in diverse ways by the lake environment. Compared to the warmer north shore, the south shore of the island is impacted by air temperature from Lake Huron, resulting in different flora and growing seasons. Here, alpine and arctic plant species are found (Coniglio, Karrow &, Russell, 2006) while Atlantic costal plant species are found on the north shore, resulting in flora that conflicts with the northern populations of reptiles and amphibians found on the same shore (Wright, 1981).

A poor understanding of the island's environment during land surveying, conducted during winter seasons, meant that the townships were not set up to be economically successful, with only small, sporadic pockets of arable land (in the regions of Barrie Island, Gore Bay, Providence Bay, Mindemoya, and Sheguiandah) combined with extensive marshland and rocky terrain (McQuay, 2013; Pearen, 2001; Wightman, 1982). The political ideal was that the island would develop into an agricultural community capable of supporting a population of 10 000 by the mid-1800s (Pearen, 2012; Wightman, 1982).

2.5.3 Romanticism

With European exposure to North America came glorified depictions of the Indigenous Peoples in an effort to promote a desire for settlement there. The romanticism attached to them began with a conceptualisation of the "noble savage," a stock character who first appeared in John Dryden's play, The Conquest of Granada (1672). The character depicts an outsider who has not been corrupted by civilisation (Moore, 2002). This fictionalised and romanticised character was perceived as innocent, virtuous, and of a peace-loving nature (Shifflett, 2012). It was not until Charles Dickens' 1853 essay "Noble Savage" that this concept gained an oxymoronic context (Moore, 2002) and became the stereotypical image for Mohawks (one of the Six Nations Iroquois – *Haudenosaunee)* in the Lower Great Lakes region (Binnema & Hutchings, 2005).

Romanticism began as a rational ethos (a mode of persuasion through character credibility, coined by Aristotle) of the Enlightenment period (defined by philosophical advancements, est. 18th century) and developed as a cultural dimension by means of attaching a peaceful, loving value to surrounding landscape. It became defined by the works of authors such as Goethe, Schiller, Shakespeare, Rousseau, and Milton (Remak, 2005; Saisselin, 1992; Shifflet, 2012).

Romantic motifs (literary and artistic concepts) gained attention with the Baroque Era, an art style that arose in Western Europe in the 19th century and idealised nature as divine in contrast to a mysterious and primal wildness (Campbell, 2003; Remak, 2005; Saisselin, 1992). The Romantic Movement originated in Britain at the end of the 18th century and was inspired by the development of tourism in America. Following The War of 1812, Americans developed an appreciation for outdoor leisure activities defined as sport and games (e.g., hunting, fishing). The attraction to outdoor recreation became the centre focus of the tourism industry with the advancements in transportation, aided by the hydrographic survey of the Great Lakes and introduction of steamboats (Campbell. 2003; Shifflett, 2012; Wightman, 1982).

Romantic ideals that first defined the Indigenous culture to the western world transpired through colonial interactions and were inferred through treaty making, displayed through annual gifts for allegiance, missionary work, the Dennis report (1826), and congregating Indigenous Peoples into remote reserves in the north away from the influence of increasing *white* settlements (Campbell, 2003; Surtees 1986; Wightman, 1982).

The distribution of gifts began at Amherstburg as a means to essentially bribe the allegiance of the Indigenous Peoples in their affairs with American colonialists. They provided them with guns, ammunition, food such as flour, sugar and tea, and cooking utensils. Following the War of 1812, gift distribution continued but as a means of assimilation rather than allegiance, as Indigenous Peoples were no longer needed as allies (Greene, 2005; Pearen, 2012). Sir Francis Bond Head (F.B. Head) (1836-1838) had the perspective that annual gift giving was a form of colonial charity, that while one culture is not necessarily better than the other, the Indigenous people needed European items. This perspective has come to reflect what has been described as romantic primitivism as defined by the concept of the “noble savage” (Moore, 2002).

F.B. Head stated that the Crown had failed to turn the Indigenous People into farmers or integrate them into civilization, so the best and most humane solution would be to remove them from contact with the expanding immigrant populations. In other words, he believed industrialism as detrimental to their well-being and was “protecting” them. In his autobiography, *The Emigrant* (Head, 1847), he claimed to reject the idea of the “degenerative savage,” a concept that implies the Indigenous culture to be inferior. The “noble” and the “degenerative” savage now deemed one in the same as his attempt to “civilize Indians” in fact degraded them (Binnema & Hutchings, 2005; Pearen, 2012).

In 1836, with the Bond Head Treaty (Treaty 45), F.B. Head completed the arrangements for Manitoulin Island as a reserve for Indigenous Peoples. At the time, government officials in London objected to this policy, to move the Indigenous People away from developing settlements, so F.B. Head was removed from his position (Pearen, 2012; Wightman, 1982).

By 1859, news outlets had begun to publish articles that promoted Manitoulin Island as a desirable place to relocate, despite the land being entrusted to the Indigenous People in this 1836 Treaty (Pearen, 2001; Wightman, 1982). One particular article entitled, “Pleasure Seekers” was published in *The Leader* (Toronto) in September of 1859. It described the Island as a fertile wilderness. The story was picked up by *New York Times* and consequently a campaign to open the island to non-Indigenous settlers followed. Other stories also ran in the Travel and Leisure section of U.K. based newspapers (Campbell, 2003; Pearen, 2012).

Romantic motifs became synonymous with the wilderness of Northern Ontario and as a result, outdoor tourism in the region was fundamentally shaped by the romantic views of nature as developed by the industry. The Canadian literary form would become defined by this landscape, embodying genres known as *romantic realism* and *regional romance*. While romantic views were promoted to support the tourism industry, actual life was difficult in these remote locations. The duality between the romanticised ideal of the wilderness and actually surviving the harsh seasonal conditions continued into the modern age, becoming central themes in the work of Margaret Atwood and the Group of Seven (Campbell, 2003; Shifflett, 2012; Wightman, 1982).

Survival is a theme of Atwood's work that would become reflected in the definition of the *Canadian identity*. The theme is depicted through two outlets, physical survival in the harsh winter conditions, and cultural survival against assimilation (Shifflett, 2012). Indigenous contributions were essential in the development of Canadian identity from this point of view as everyone had to adapt survival techniques specifically learned through practice and experience within the dynamic climate of the northern environment (Campbell, 2003).

Group of Seven artists visited the shores of Georgian Bay in the early 1910s. Their imagery, depicting the small islands of pre-Cambrian rock and sparse coniferous forests, embellished the ideal of wilderness that separates the region from the rest of the Great Lakes and the near north. Their leaning pine would became a generic symbol of the north land (Campbell, 2003; McQuay, 2013; Wightman, 1982).

The duality of romanticism of the Georgian Bay and Manitoulin Island region was also reflected in the view of it being a remote and divine location, situated in the middle of a key passage for transportation and access to the west. Lake Huron, while considered remote and isolated through romanticised depictions, could not be fully considered as a separate, romanticised, wild environment as at the same time it was gaining a large attraction to the availability of natural resources (particularly interesting the fishing and lumbering industries) (Campbell, 2003; Wightman, 1982).

2.5.4 Colonial Relations

In 1615, Samuel de Champlain, travelling the French River, met the Odawa who called Manitoulin Island their home (Pearen, 2012; Pearen, 2001; Valenti, 2016). Following his expedition, colonisers arriving to northern North America came largely from two different nations, Britain and France, and established separate settlements and seasonal trading posts in the interior. The fur trade developed as a network of trade between the Indigenous Peoples, and the British and French. Due to the location of coloniser settlements and territories, the *Anishinaabe* of Manitoulin Island were mostly in contact with the French (King, 2012).

In 1648, the French Jesuits first arrived on the island, which at that time they named Sainte-Marie or St. Mary's Island. At first, they lived among the Odawa on the eastern peninsula of the island that became known as Manitowaning. Here, the Jesuits eventually established the missionary of Saint-Pierre (Poncet) as a part of the proselytization of evangelisation throughout the Indigenous populations (Fay, 2002).

This distribution of gifts was a strategy used by the government to control the Indigenous populations by supplying them with imported goods such as guns (but no ammunition) that would keep them feeling grateful for the generosity and yet still needing more (Greene, 2005; Pearen, 2012). Following the conclusion of the War of 1812, work in 'Indian Affairs' was directed towards assimilation (Talbot, 2011). The war led to a hydrographic survey of the Great Lakes which first brought political attention to Manitoulin Island in the 1829 Dennis report. It was reported that 50% of the island was suitable for "farming purposes" and it could support a rural population at a tolerable economic level (Wightman, 1982).

During the first half of the 1800s, Sir John Colborne, Lieutenant Governor of Upper Canada discussed plans to turn the island into a "great" reserve where all Indigenous People could live separate, an idea that was first met with disapproval by the Crown. He was inspired by the 1834 Coldwater reserve (near Port Severn, Ontario). As a last effort to turn the island into a reserve, Colborne arranged for Manitowaning to become the new site, moved from Amhertburg (near Detroit), for the annual delivery of presents (Greene, 2005, Pearen, 2012). In 1836, Colborne's successor, Sir Francis Bond Head, carried out the arrangements of the Manitoulin Island reserve, with the Bond Head Treaty (Binnema & Hutchings, 2005; Pearen, 2012).

The 1850 Robinson Treaties (Robinson Superior Treaty and Robinson Huron Treaty) had the Indigenous Peoples formally surrender their rights to the territory (Pearen, 2012). Prior to the cessions, mining licenses were unlawfully issued, bringing immigrants to the shores of Lake Huron and Lake Superior, and closer to Manitoulin. Similarly, licenses were also issued to the colonists and Métis for Indigenous owned fisheries in the waters surrounding Manitoulin. The encroachment of settlements lead to the frustration of the Indigenous People of Wikwemikong and the opposition of all governmental advancements to colonisation. For this reason the Indigenous People of Wikwemikong were absent at the signing of the 1862 McDougall Treaty and the peninsula remains unceded to this day, and is the only unceded territory in Ontario (Pearen, 2012; Surtees, 1986).

The logging industry also put a strain on relations with the Indigenous People due to the control of leases and supposed negotiations of fishing stations and land for timbering (Pearen, 2012; Wightman, 1982). Prior to the treaty, the island was divided into hunting territories, the length of a half day's walk. The North Shore, which refers to the mainland shore of Georgian Bay, was important hunting grounds for the inhabitants of Manitoulin Island, for bear, moose, and caribou. Though these larger animals were present on the island, prior to the clearing of the land, sightings were more uncommon due to the dense bush (Greene, 2005; Pearen 2012; Pearen 2001; Wightman, 1982). These important hunting grounds were significantly reduced by the impacts of the Robinson Treaties in Canada, and the Washington Treaty in the United States (Pearen, 2012).

For subsistence, the Indigenous Peoples on the island hunted, fished, and gathered (Pearen, 2001; Wightman, 1982). They produced maple sugar, and raised corn and potatoes in small gardens. Well into the 1880s, communities consisted of wigwams made from birch and cedar. After the island was opened to colonial settlement, some would work short-term labour jobs such as clearing land, or as drivers, sailing schooners. Prior to the 20th century, payment for these services was in goods such as food, crops, flour, and farm animals (Derry, 2012; McQuarrie, 2006).

Around the time of the 1862 treaty, the Indigenous population of the island was recorded as approximately 1250 (Pearen, 2012); however, the population was much larger as many refused to participate in the census. Governments saw treaties as a means to settle the question regarding ownership of the land. A number of treaties impacted the people of Manitoulin Island from 1836 until the 1876 Indian Act that declared Indigenous People as wards of the state, under the jurisdiction of the federal government (Daschuck, Hackett, MacNeil, 2006; King, Smith & Gracey, 2009).

Colonial settlement of the island occurred rapidly and by 1891 the population of the Island was approximately 10,000 with the largest towns being Gore Bay and Little Current (Putnam, 1947). Migration and rapid expansion tends to improve the availability of benefits in the long term, though benefits do not occur in a uniform fashion. It is well known that in the short term migration and rapid expansion decreases resource availability and increases the risk of disease, resulting in exposure to new microbes, changing economic resources and investment problems, and negatively impacting health trends (Dye, 2008; Kanaiaupuni & Donato 1999). The short term impact is generally increased poverty, reflected in the declining health of children (Aber, Bennett, Conley & Li, 1997; Higgins, 2003; Rice, Sacco, Hyder & Black, 2000).

2.5.5 Natural Resource & Tourism Industries

Beginning in 1836, the first steamship on Georgian Bay, the *Str. Penetanguishene* made travel around the island easier. Over time many sidewheel steamers would follow and were used to promote tourism as well as transport passengers and goods such as lumber. Steamers called at notable ports such as: Sault Ste. Marie, Espanola, Killarney, and Penetanguishene on the mainland; and Little Current, Gore Bay, Meldrum Bay, Silver Water, Kagawong, Manitowaning, and Michael's Bay on the Island (McQuarrie, 2006; Pearen, 2001).

In the 1840s, fishing brought settlers to Georgian Bay before logging. The commercial fishing industry had established itself by the late 1850s using gill nets to catch trout, whitefish, pickerel, and bass (Wightman, 1982). The pound net, a Scottish technology, was introduced in the region in the 1880s and was still considered innovative into the 1900s. Gill nets were less sophisticated and easier to manage in comparison to pound nets which required larger boats and a crew. Gill nets catch fish by the gills as they swim through, while pound nets funnel fish into a trap in the centre (Derry, 2010). By 1942, over-fishing, in combination with the introduction of the lamprey via the Welland Canal, resulted in a significant decline of fish populations (Pearen, 2001). Sturgeons were fished, particularly by the Indigenous People who would spearfish at night by torches. Sturgeons were considered a nuisance in the commercial industry as they damaged nets and did not provide a valuable meat for consumers; as a result, they were valued more for their roe, or eggs (Derry, 2010).

The 1862 McDougall Treaty (or Manitoulin Island Treaty) was pursued largely to obtain the rich soils of Manitoulin Island (Pearen, 2012; Wightman, 1982). Thus colonisation efforts of the island were driven by the desire to acquire the arable lands as well as to acquire access to the surrounding waters for the fishing industry. William McDougall, the Superintendent General of

Indian Affairs was appointed to negotiate land purchase from the Indigenous People. As incentive to sell, the Indigenous People were offered 100 acres of land located within white settlements. Ultimately, the absence of the Indigenous People of Wikwemikong from meetings meant an inability to ratify the treaty, which led to further problems with control of the fisheries and even the murder of the fisheries commissioner, William Gibbard, in what was called 'The Manitoulin Incident' (Greene, 2005; Surtees 1986).

In 1865, the logging industry began in the area of Collins Inlet where new settlers to Manitoulin Island were first employed in a logging camp. The first official mill on Manitoulin Island was opened in Little Current in 1874. In 1883, the settlement adopted the nickname of Sawdust Town (McQuarrie, 2006). Prior to the 20th century, there were few jobs on the island aside from clearing the land, and lumber camps on the shores of Georgian Bay. The seasonality of the logging industry corresponded well with the farming season (McQuarrie, 2006; Valenti, 2016).

On Manitoulin, the clearing of the land in the latter half of the 19th century produced timber that was used to construct buildings, fences, boats and docks. Most island inhabitants survived off small gardens that provided for their household (Derry, 2010; McQuarrie, 2006). Those who were not employed in logging camps throughout the winter worked producing railway ties and pavement posts that were shipped to Owen Sound; and by the 1880s, this had become a common practice, particularly in the area of Providence Bay (Pearen, 2001).

Logging camps were the main source of employment as the island was cleared. The work was quite isolated through most of the logging season (November to March) as labourers were out of their home communities. Horses were the most important commodity, thus blacksmiths played a key role in the timbering portion of the logging industry. Lumber camps provided a range of employment opportunities related to extracting timber including ‘cutters’, ‘fitters’, ‘swampers’, and ‘skidders’. ‘Drivers’ conducted horses which were used to pull logs, water tanks, and sand across snow and ice. Some schooner operators were identified as ‘drivers’ and were employed for a two month period following the spring melt; they would guide logs down the river to destined sawmills. A foreman and blacksmith, along with cooks, carpenters and washerwomen, maintained the camp and serviced equipment and horses. A doctor usually made a seasonal visit but was not commonly available due to the isolation of the camps (Derry, 2010; McQuarrie, 2006).

The isolated environment on Manitoulin Island meant access to goods and services was limited. Transportation between the island and the mainland was made possible by boats and steamships following the spring break-up of ice in March or April. Most of the local Indigenous People had access to boats, canoes, sailboats or mackinaws that were also used on the inland lakes. Freeze-up refers to the time of the year when boats were pulled out of the water, the ice formed, and people became quite isolated; this began around November. During the freeze-up, weather was severe, cold, and transportation included snowshoes, and horses pulling sleighs or more commonly cutters, a smaller more maneuverable sleigh. Traversing across the ice was dangerous, often resulting in accidents and frostbite, leading to amputation and sometimes even death. The introduction of cars in the 20th century did not replace horses in ice travel for some time (Derry, 2010; McQuarrie, 2006; Wightman, 1982).

Trapping rabbits and partridge hunting were common activities on the island. Beginning in the late 1880s, caribou populations, once common on the south shore, began to decline and deer populations rose, a species that had not been present on the island previously (Valenti, 2016). Sightings increased with the clearing of the land. The increase of the deer population brought wolves to the island which became a larger threat to settlers and their livestock than bears had been during the clearing of the land (McQuarrie, 2006).

The Manitoulin Expositor, the island's most successful newspaper, was established in 1879 in Manitowaning. It expanded the island's already significant tourism industry. By 1880, there were nine licensed hotels. People came for the sightseeing, fishing, and hunting; many even took up a summer residence (Derry, 2010; Pearen, 2001). In the 1880s, flour was the most popular commodity, processed from grain at a gristmill. In the 1890s, farming shifted to oats and hay and, by the turn of the century, cattle and lambs were not uncommon. Dairy farming began in the area of Mindemoya and became a common practice into the 1900s. In the 1920s, turkeys were introduced, in part to control the island's increasing grasshopper population (McQuarrie, 2006).

In 1913, a swing bridge built by Algoma Eastern Railway was opened, allowing for train access to Little Current. In 1945, the bridge, now controlled by the Canadian Pacific Railway was opened to cars. Earlier in 1938, the hazardousness of travel across the ice led to the installation of a small steel bridge-dock allowing for year round passage (McQuarrie, 2006, Pearen, 2012).

Indigenous communities on Manitoulin Island were divided in terms of enlistment for the Great War (WWI). Those who had experiences with the "whites" fought to boycott enlistment of their people. In the end about 13% of the 384 eligible men did serve (Talbot, 2011; 103). These individuals generally had not yet experienced life outside the community and had seen enlisting as an escape. Other war efforts were documented through raising money and donating to the Red Cross Society in Gore Bay (Talbot, 2011).

2.6 This Study

Both the epidemiologic transition between Omran's (1977) ages of 'receding pandemics' and 'degenerative, human-caused diseases' and the transition of an era in societal development (colonial to modern, industrial) coincides with this historical analysis. The research is investigative, drawing on an eco-epidemiological approach that considers the impacts of the contextually-defined environments (explored through ecology) in the interpretation of cause of death trends observable on Manitoulin Island (Ontario, Canada) for the period from 1870-1908 and 1921-1936. Current understanding of multifactorial disease pathways and the contextual environment suggest that there will be a combination of cause of death trends attributable to acute and chronic complications as well as infectious and degeneration, non-communicable complications. This period of study is consistent with the transition of disease impacts that is described in the epidemiologic transition model (Omran, 1971). It is also a region particularly impacted by colonisation and immigration. It is likely the latter will have a notable impact on cause of death trends observed in this dataset. The questions explored in this study are:

1. What historical-ecological aspects of society played a role in influencing disease causation on Manitoulin Island? How do these factors define the contextual-environment?
2. What trends in death reflect patterns of infectious or chronic non-communicable diseases? How do these patterns compare to the epidemiologic transition model?
3. What impacts of the contextual environment on Manitoulin Island have on mortality?

CHAPTER 3. METHOD

3.1 Introduction

This research examined trends in mortality using data extracted from death records from Manitoulin Island, Ontario, Canada extending from 1870 to 1936 (with only ten deaths recorded from 1909-1920) and supplemented with census data (1881, 1891, and 1901) and birth records (1877-1908). The start of observable trends in chronic complications and disease for this population and era were of particular interest. Ethics approval was not required to carry out this study, however, in recognition of the small region under study and the potential for ongoing residence of descendants in the region, no personally identifying data (such as individual names) was transcribed into the project's database.

In this study, the research approach was investigative and of a mixed-method design (Venkatesh, Brown & Bala, 2013). It explored data and information extracted from the Ontario birth index (1877-1908), death index (1870-1908 & 1921-1936), and census reports (1871, 1881, 1891, 1901, and 1911) as well as literature depicting historical life on Manitoulin Island. The purpose was to use historical data, particularly death records, to explore trends in causes of death to generate a narrative that describes contextual health risk factors of the region and how they played a role in impacting trends in causes of death particularly transitioning from acute to more chronic as described by the epidemiologic transition. This narrative was achieved by determining meaningful patterns within the contextual limits of the data compared to the qualitative interpretation of the lifestyle and how that impacted disease causation. This process involved determining categories that meaningfully organise the measurable variables available within the datasets and interpreting comparisons between these categories to the contextual environmental variables that may have contributed to shaping the observed trends in the causes of death.

When considering archival data, a study is observational with no intervention except when examining and categorising the available variables for measure. Such studies are considered retrospective. With retrospective, historical research, the quality of data often presents a key disadvantage (Ludlow, 2017). To address the interpretation of these data, methods have focused more on a qualitative approach due to the inadequate availability of quantitative data, simply an unfortunate reflection of the region and time period. Using a combination of qualitative and quantitative methods requires the researcher to apply a multilevel approach.

3.2 Data Sources

As part of the quantitative portion of the study, each dataset was assessed for applicability to the study. The datasets, originally part of the Registered Records of the Province of Ontario were obtained through Archives of Ontario (birth data collected online through Ancestry.ca). The census data were acquired for 1871, 1881, 1891, 1901, and 1911. The categorisation of data evolved by location depending on census year as the island's population grew and townships were surveyed. In 1871, the census was divided into three sub-districts, Manitoulin: center (immigrants and settlers), and east and west (Indigenous population). In 1881, the census began to represent the sub-districts based more on individual townships, including: Allan, Assiginack, Barrie Island, Bidwell, Billings, Burpee, Campbell, Carnarvon, Cockburn Island, Dawson, Gordon, Howland, Mills, Robinson, Sandfield, Sheguiandah and Tehkummah (Fig. 2.3). The Indigenous records included registrations from the following reserves of which over time, many have been identified by multiple names: Birch Island/Whitefish River, Manitowaning (Indian Agency), M'Chigeeng/West Bay, Sheguiandah, Sheshigwaning, Sucker Creek (now Aundeck Omni Kaning), and Wikwemikong/South Bay. Aside from location, other variables drawn from the census data included: age, birth month, birth year, familial role, name, nationality, and sex.

For all of Ontario, from 1869 to 1913, the birth index includes over two millions entries. For Manitoulin Island, however, birth records available only spans from 1877 to 1908. No births records exist prior to 1877 and records are missing from 1909 to 1920. As a result births from 1909 to 1913were excluded from the analysis. The birth dataset used in this analysis includes 4775 entries and the variables: birth date (day, month and year), location, name, and sex. Birth records were not available following 1913.

The death records dataset used in this analysis spans from 1870 to 1908 and 1921 to 1936, again due to a lack of data between 1909 and 1920. These data include 4313 entries and the variables used in this analysis were age, birth date, death date, primary and underlying causes of death, place of birth and death, duration of illness, and occupation. Additionally information regarding the physician in attendance for diabetes-related deaths is specifically considered.

Inadequacy of the data pertaining to the Indigenous People is also consistent with the time period and region. As such, and other factors regarding research sensitivities, interpretations that specifically reflect this population are not described in detail to avoid misrepresentation of this data.

3.3 Method Design

Application to historical health research can provide insight into the multifaceted processes of disease causation as a result of health inequalities (Ludlow, 2017). The mixed-method approach in this study combines objective (archival data) and subjective (intersection) methods. The application of intersectionality in particular is an important aspect of this study design as it specifically connects contextual information from the literature and the data. The application of intersectionality is particularly important in the analysis and interpretation portions of this study. Coding, the method of categorising the data into measurable variables is a key process of the analysis as it impacts the outcomes. This categorisation is a necessary first step to analysis and results in the creation of meaningful units for data comparisons. As such, systematic attention to theory must be paid to avoid influence of the reviewer (Bauer, 2014).

By categorising the data, the researcher is applying an evaluative process that is done through consideration of context-relevant information, thereby interpreting the dataset in order to develop a narrative regarding the variables. The context-relevant information used in this study reflects that of historical accounts on societal development and medical advancements, and knowledge of theoretical trajectories of cause and effect and its application to disease causation (see Chapter 2).

This coding process means the reviewer needs to be as aware of and address bias as much as possible to ensure the resulting analysis does not obscure or incorrectly highlight certain results (Krieger, 2001a; Krieger, 2001b). This potential issue was demonstrated when Szreter (1988) re-ran McKeown's (1976) dataset and found different results. Systematic attention to theory is the essential key to understanding the practicability and benefits of diverse approaches to analysing and interpreting population patterns (Krieger, 2001a; Krieger, 2001b).

Cause of death records, particularly historical are difficult to evaluate due to changing, diagnostics, consistent with a period of rapid growth and transition between major disease impacts (such as for the data reviewed in this study). The application of intersection has been adapted to examine categories specific to plausible death impacts. In these applications, categories are used pragmatically to explore death from different societal positions. Intersection explicitly acknowledges and deliberately considers construction of measurable variables and thus reflects a form of mixed-methods design (i.e., qualitative and quantitative together). (Bauer, 2014; McLaren & Hawe, 2005; Venkatesh, Brown & Bala, 2013).

Omran's (1971) epidemiologic transition model, expansions and key insights from Defo (2014), McLaren and Hawe (2005) and Zuckerman and his colleagues (2014), and Mercer's (2014) research describing the relationship and differences in infectious and chronic diseases are all key resources that provide categorisation and disease-related concepts and language that are essential in social epidemiologic research and therefore comprehension of the qualitative portion of the study. This is achieved through the interpretation of cause of death patterns by applying the contextual understanding of different environments outlined specifically by the 'distal and macro-contextual variables' in Defo's (2014) eco-epidemiological life course framework (Fig. 2.1) to extract a conclusion that reflects the overall impact of cause of death trends experienced by the different communities specific to Manitoulin Island.

Omran's (1971) model is not sufficient by itself as all epidemiologic studies are context-specific, and groups within a larger population may undergo transitions at different times (Defo, 2014). Disease and social factors are not seen as existing in isolation, but an ever-changing complex of individual intersections (Bhurga, 2014; McGibbon & McPherson, 2011). The lack of socioecological perspective in the original epidemiologic transition is best mediated using the theoretical concept of *intersection* which understands health as patterns of relations and is applied through the analysis and interpretation of the results.

3.4 Dataset Management

The death records were the main focus of the analysis. The dataset of 4313 entries consisted of 12 variables which were utilised in this study and are described below (see Table

3.1). Each variable was reviewed to assess limitations, be classified into mutually exclusive groups and be compared to other variables.

Table 3.1

Death Index Dataset Variables

Variable	Description	% of available sample	Accessibility
Place of birth	Place of birth globally defined	92.5	Constructed
Societal cohort	Defined by place of birth & death	93.4	Constructed
Place of death	Place of death by region	98.1	Constructed
Death Year Range	Intervals of 5 & 10 years (1870 – 1936)	99.8	Available
Sex	Male and Female	99.7	Available
Age at death	Stillborn to 105+ years of age	98.1	Available
Life stage	Defined by age at death (infant to elderly)	98.1	Constructed
Month of Death	January to December	99.5	Available
Season of Death	Spring, Summer, Autumn, Winter	99.5	Constructed
Occupation	Occupation at time of death	90.3	Constructed
Primary COD	Immediate cause of death (COD)	92.8	Constructed
Underlying COD	Underlying cause of death (COD)	19.7	Constructed
Acute-Chronic	Based on CODs, duration of illnesses	74.4	Constructed
Total	Entry Count n = 4313	100%	

Available – uncategorised data; constructed – categorised and coded data.

Initial analyses surfaced three distinct demographic groups that were defined by place of birth. As a result, the specific locations within the variable, *place of birth* were grouped into the corresponding regions: local (Manitoulin Island), national (North America), and global (international). Further, the variables *place of birth* and *place of death* were used together to define a new variable called *societal cohort* representing: *band*, those whose place of birth or death (if birth was absent) was associated with an Indigenous band; *settlers*, likely European descendants who were born within Canada or the United States, and were not specifically tied to Indigenous locations; and *immigrant*, those who were born overseas.

Within the original dataset, both the raw data for *place of birth* and *place of death* was recorded by specific settlement, an organised township or district, or a generalised region. *Place of death* variables which are mainly from Manitoulin Island were re-categorised into the regions defined by townships (Fig.2.3) and then grouped into regional categories: *north east*, *unorganised west*, *south shore*, *north shore*, and *bands/reserves* (see Table 3.2).

Table 3.2

Manitoulin Island Regions

Subsection	Townships Within
Band	Wikwemikong, West Bay (+ others*)
Off Island	Algoma, Nipissing, Western ON
Unorganized West	Burpee & Mills, Robinson, Cockburn Isl.
North East	Bidwell, Billings, Howland, Sheguaindah
North Shore	Allan, Barrie Isl., Gordon
South Shore	Assiginack, Carnarvon, Campbell, Sandfield, Tehkummah

(*) See above for list of Indigenous reserves on Manitoulin Island, section 3.2.

The years recorded in the *death year* variable spanned from 1870 to 1936; however, through initial analyses, it was determined that records ranging from 1909 to 1920 are almost nonexistent. This variable was recoded into ranges of five and ten years. The variable, *birth year*, while not specifically used in the analysis, was used to determine entries that were missing *age at death*.

In this dataset, *sex* represented the biological definition of male or female and was a binary category. *Age at death* was represented by decimal and extended from 0 (still birth/premature) to 106.42 (or 106 years and 5 months). In some cases, age was recorded in months, weeks, days, and hours as well as years (weeks, days and hours were most commonly used for under one year of age). The *life stage* variable was derived from age at death and represented: *infant,* aged 0 to 0.99 (less than one year); *child,* aged 2 to 14.99; *young adult,* aged 15 to 29.99; *adult,* aged 30 to 59.99; and *elderly,* aged 60 or more.

Month of death represented January to December and was grouped into seasons: spring (March to May), summer (June to August), autumn (September to November), and winter (December to February).

Occupation was considered for only cases where age at death was 15 years of age or older (*life stage* young adult, adult, and elderly). The categorisation of this variable is outlined in Table 3.3.

Table 3.3

Occupation Variable

Category	*Description*
Trade Goods & Services	Food Services, Sales
Domestic	Housekeepers, servants
Specialist-Official	Government officials, intellectuals, desk jobs
Labour-Trade	Trade occupations considered labour intensive
Farmers	Farmers and farm labourers
Rank	Too young/old to work and familial attachments

3.4.1 Cause of Death Coding

Systematic attention to theory helps in benefiting diverse approaches to categorising causes of death for evaluation purposes. Along with advances in society and knowledge, disease categorisation as methods of diagnosis have changed, most notably across the latter half of the

19th and early part of the 20th centuries. The development of the 1880s germ theory had a particular impact on public health as it created a better understanding of the microbial impacts in the spread of infectious diseases. Death records dating from this time period are expected to reflect an era of changing diagnoses between the “old” and “new” world developments as reflected by the transition through the industrial revolution (Ludlow, 2017; McInnis, 2000a). The resulting causes of death are explained by the epidemiologic transition.

Health, as impacted by risk factors and pathways in multifactorial causations of diseases, can be defined by illness, sickness, and disease. Illness reflects how an individual interprets their health. The term sickness represents how the community interprets their health. Disease reflects the diagnostic categorisation systems developed within the institution of medicine and generally represents a doctor’s interpretation of symptoms (Krieger, 2001a).

As specific microbiological understandings of diseases were not within the scope of this study, causes of death were taken at face value. On Manitoulin Island, resources were limited and would have impacted the availability of both doctors and their ability in diagnosing causes of death. While some records within the dataset alluded to the completion of a post-operation or autopsy, for the most part, these types of activities were not indicated as common practice until after 1921. Causes of death overall either embodied a well-known infectious disease or a non-specific symptom, the latter eluding to a number of different conditions caused by a variety of risk factors.

In order to compensate for registration issues and changing diagnostics for this time period, cause of death coding was first approached by determining the range of causes of death represented by the data. Information regarding specific causes of death was available within two variables: *primary cause of death* and *underlying cause of death*. For some records, an extra note was also available, providing further details and/or the duration of the health impact prior to death.

Confusion and misclassification through nomenclature are common complications as there are a variety of different terms for the same class of health condition (Barkin & Gentles, 1990). Causes of death were considered within the literature for historical definitions of causes of death (e.g., atrophy, catarrh, dropsy, la grippe) (Thornber, 2017). The specific organ complications were inputted into the search database for the *World Health Organisation International Classification of Diseases* (WHO, 2013) to determine the most likely definition and implication on health that would latter help to elude to specific disease complications regarding co-morbidity (comparisons of primary and underlying causes of death).

Both the *primary* and *underlying causes of death* raw data were categorised using the same two-layered code (see Table 3.4 and Table 3.5). Primary causes of death reflect the immediate health complication the resulted in death. Underlying causes of death reflect a separate variable in the dataset that identifies, if present, a condition diagnosed prior to death therefore possibly reflecting impacts of co-morbidity.

Table 3.4

First Code for Cause of Death

Category	Outline
Infant-Maternal	Childbearing and childbirth complications
Cerebrovascular	Brain, spine and nerve complications
Cardiovascular	Heart complications
Respiratory	Respiratory infections and complications of the lungs
Digestive*	Complications of digestive organs, associations with unsanitary conditions, malnutrition
Organ-specific*	Liver and kidney, bladder and other specific organ complications
Known disease	Cancer, blood infections, immune disorders, STDs
Non-Specific	Old age, accidents, generalised complications

(*) Collapsed into the category "other organ" due to small quantitative size and similarity in causes of death.

Table 3.5

Second Code for Cause of Death

Cause of Death			
Category	Specific Causes	Category	Specific Causes
Infant-Maternal	Stillborn premature fetal weakness colic-teething umbilical hemorrhage child labour complications eclampsia ill from birth/ defects	Cerebrovascular	non-specific fevers meningitis/ neuritis/ myelitis/ encephalitis specific atrophy convulsions/ fits/ epilepsy nerve complications hydrocephalus paralysis brain disease/ abscess apoplexy/ stroke/ hemiplegia
Cardiovascular	non-specific/ inflammation endocarditis/ myocarditis valve dilation complications cardiac atrophy/ weakness heart failure sudden heart-related death	Respiratory	non-specific/ inflammation tuberculosis/ phthisis/ consumption whopping cough asthma influenza diphtheria lower respiratory tract infection upper respiratory tract infection specific cirrhosis/ abscess/ disease atelectasis
Digestive	non-specific/ inflammation gastritis-/colitis/enteritis/peritonitis specific hemorrhage/rupture diarrhea/constipation/dysentery indigestion obstruction cholera specific disease marasmus/starvation/nutritional deficiencies	Organ-Specific	non-specific/inflammation liver complications kidney complications gall bladder complications diabetes prostate complications
Known Disease	non-specific/inflammation typhoid measles scarlet/rheumatic fever blood infections/septic shock cancer gangrene erysipelas	Non-Specific	non-specific inflammation/rupture/blood clot old age physical intervention muscular-skeletal disability insanity/mental complications

	sexually transmitted disease (STD)	

The dual, two-layered codes (category and specific causes in Table 3.5) allow for sub-categories of variables to be isolated during the analysis process. The first code represents a generalised category of cause of death and the second code reflects a wider range of more specific causes of death within the category. Cerebrovascular, cardiovascular, and respiratory related deaths generally address complications of the upper portion of the human body. Digestive and other organ related deaths generally address complication below the abdominal wall. Other known complications and non-specific related deaths generally address more holistic complications that could impact numerous bodily systems or regions and infant-maternal related complications that are self-explanatory. During the analysis process the category can be isolated in order to observe the impact of the specific causes. This allowed for the consideration of more specific causes of death during the evaluation process and comparison of different variables.

This study focuses more on the contextual environmental impacts on disease and death for the region rather than biological understanding of disease process; however, the latter still played an important role in the coding process and interpretation. Specific risk factors and multifactorial pathways of disease causation can often be understood as a result of a certain lifestyle or lifetime. Knowledge regarding disease impacts during this period, such as high respiratory deaths and low infant survival (Mercer, 2014; Omran, 1877; Zuckerman, et al., 2014) was used to inform the initial coding. Infant survival in particular was largely dependent on maternal health and common infectious disease outbreaks (Mercer, 2014; Zuckerman, et al., 2014),

Following the initial analysis, a third layer or code was developed to further explore the incidence of cancer and death due to a physical injury. The complications are outlined in Table

3.6. This code allowed for isolation of these deaths more specifically from their respective first code, known diseases and non-specific categories.

Table 3.6

Cancer and Physical Injury Cause of Death

Cause of Death			
Category	Specific Causes	Category	Specific Causes
Cancer	bladder	Physical Injury	accident
	brain		impalement/fracture/blunt force
	breast		fall
	cervical/prostate		accidental/intentional drowning
	face		accidental/intentional gunshot
	liver		fire/burns
	lower abdominal		suicide
	lower extremity (leg)		poison
	Hodgkin's & other glands		exposure to cold
	Leukemia		derailment of train car
	lung		steamboat accident
	pancreas		asphyxiation/accidental
	Non-specific/malignant tumor		suffocation

The *underlying cause of death* variable (if available) represented a condition pre-existing the primary cause of death, therefore likely a contributing factor in death (co-morbidity). The recoded dichotomous variable, *acute-chronic* (which defined acute versus chronic), represented the information provided under both primary and underlying causes of death and particularly the duration of illness. If the duration was longer than six months it was considered chronic and acute if less than six months. This variable was used to compare age at death and determine which conditions were representative of more long-term health impacts that resulted in mortality. As the availability of underlying conditions is likely representative of a registration bias, it was not considered as a complete variable. Causes of death that were not indicative of either acute or chronic time frames were not coded and thus omitted from the interpretation.

3.5 Data Analysis

All statistical analyses and the creation of graphs were carried out using IBM SPSS Statistics software and Microsoft Excel. As this study is an exploratory analysis, each variable was first assessed individually. The bivariate statistical test used for nominal data was the chi-square test of association which assesses whether two variables are associated. The difference between the chi-square test of association and the chi-square test of independence is that the test of association does not distinguish between an independent and dependent variable. The SPSS output for these tests produced a value for the Pearson chi-square coefficient that in this study was determined to be statistically significant at $p < .05$. To measure the strength of association of the appropriate relationships, Cramer's V was used.

A pairwise comparison, using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons was used to determine which group (or mean rank) differed from the rest of the distribution (or mean ranks).

Abridged life tables were produced for 1881, 1891, and 1901 census years. This table allows for the examination of survival rates by age groups for the hypothesised population given the available measures of the data that is available. The specific variables produced for these tables are described in Table 3.7. Analysis was completed in Microsoft Excel and instructions from the online platform, MEASURE Evaluation Project (N.D.) were followed to carry out the calculations. The abridged lifetables were used specifically to observe the survival rate by age range between 1881, 1891, and 1901 for Manitoulin Island.

Table 3.7

Life Table Column Notation

Column	Notation	Definition
1	*(x, x+ n)*	Age interval/period of life between two exact ages stated in years
2	${}_nq_x$	Proportion alive at the beginning of the age interval who die during the age interval
3	l_x	Of the starting number of newborns in the life table, the number living at the beginning of the age interval (or the number surviving to the beginning of the age interval)
4	${}_nd_x$	The number of persons in the cohort who die in the age interval *(x, x+ n)*
5	${}_nL_x$	Number of years of life lived by the cohort within the indicated age interval *(x, x+ n)* (or person-years of life in the age interval)
6	T_x	Total person-years of life contributed by the cohort after attaining age x
7	e_x^0	Average number of years of life remaining for a person alive at the beginning of age interval x
	Sx	Survival Rate

(MEASURE Evaluation Project, N.D.)

CHAPTER 4. RESULTS

Tables 4.1 displays census-derived population size frequencies by region from 1871 to 1911. The counts suggest an increase in overall population size.

Table 4.1

Census Data by Region

Region	1871*	1881	1891	1901	1911
Allan		305	317		215
Assiginack		881	751	1150	665
Bidwell & Sheguaindah		812	882		689
Billings & Campbell		884	1182	1157	1087
Burpee, Robinson & Barrie Island		536	712	902	615
Carnarvon		547	500	757	780
Dawson & Cockburn Island		260	341	468	642
Gordon, Gore Bay & Mills		779	1116	1733	1336
Howland & Little Current		544	1249	1877	1909
Sandfield		480	281	283	294
Tehkummah		506	405	545	577
Total Immigrants and Settlers	481	6534	7736	8872	8809
Total Band	1561	1519	1191	1806	2113

**Census data are divided into three sub-districts of Manitoulin Island: center (immigrants), and east and west (Band).*

Table 4.2 displays frequencies for data available from the death, birth, and census reports by Manitoulin Island Townships. These data were used to construct life tables shown in Tables 4.5, 4.7, and 4.9. The number of births and deaths in comparison to the census years suggest a registration bias, and likely reflects the under registration of both births and deaths based on the population size.

Table 4.2

Census, Death and Birth Counts

	Census			Number of Deaths			Number of Births		
Township	1891	1901	1911	1881-1890	1891-1900	1901-1910	1881-1890	1891-1900	1901-1910
Allan	317		215			1	13	12	9
Assiginack	751	1150	665	115	108	77	37	191	193
Barrie Island	209	268	206	10	3	2	7	30	11
Bidwell	458		388				3	6	22
Billings	635	402	535	28	33	33	13	100	130
Burpee	186	285	292	3	27	28	36	119	110
Campbell	547	699	552		9	5	22	59	105
Carnavon	500	757	780	16	35	46	21	109	108
Cockburn Island	240	301	319	6	1	7	22	49	81
Dawson	101	167	323		2	1	5	22	46
Gordon	455	761	429	16	64	50	24	197	264
Gore Bay	472	723	702	6	87	61	40	232	156
Howland	1249	1877	1909	129	138	206	102	397	448
Mills	189	249	205		9	16	10	19	11
Robinson	317	220	117	3	18	41	3	99	114
Sandfield	281	283	294	24	20	22	4	28	71
Sheguiandah	424	73	301				2	3	13
Tehkummah	405	521	577	29	22	24	41	123	129

Table 4.3 displays the number of immigrants and settlers in the 1891 census that are matched to the 1881 census. These matched cases were identified through a process that was forgiving of the repetition of exact spellings and birth dates. This analysis was conducted to determine the reliability of data comparisons between the 1881 and 1891 census for the Manitoulin Island region. The result reflects a poor comparison that supports the understanding that enumeration records were generally quite unreliable during this period (McInnis, 2000a).

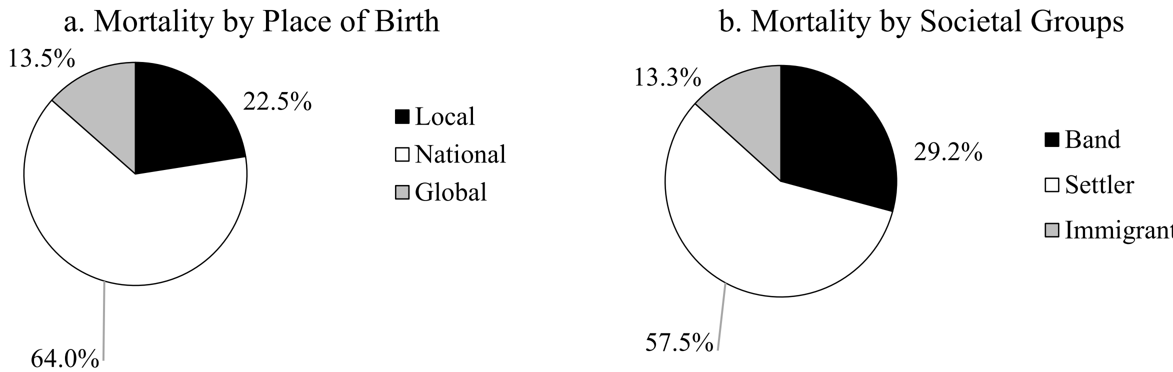

Figure 4.1. Mortality distribution defined by place of birth and death.

Table 4.3

Immigrants Identified in 1881 Census, Manitoulin Island District

Sex	*N*	Also identified 1891 Census	% in both Censuses
Male	3533	1409	39.9
Female	2982	1035	34.7

Table 4.4 displays data from the 1881 census and the frequencies of deaths in the records available from 1879 to 1883 which were used to calculate the rate of death. The death rate is high for less than one year of age and declines before increasing slightly in the 15-19 year age range and peaking in the age range 20-24. The rate peaks again for the age range of 35-39 year, dropping and then increasing to peak in the age range of 70-74 years.

Table 4.4

1881 Death Rate

Age Interval	Number of Deaths between 1879-1883	Annual Average Number Deaths	1881 Census	Rate of Death
< 1	38	7.6	217	0.0350
1-4	30	6.0	927	0.0065
5-9	8	1.6	998	0.0016
10-14	4	0.8	844	0.0009
15-19	10	2.0	691	0.0029
20-24	12	2.4	672	0.0036
25-29	8	1.6	526	0.0030
30-34	5	1.0	406	0.0025
35-39	7	1.4	347	0.0040
40-44	3	0.6	280	0.0021
45-49	8	1.6	256	0.0063
50-54	6	1.2	149	0.0081
55-59	4	0.8	98	0.0082
60-64	8	1.6	87	0.0184
65-69	8	1.6	53	0.0302
70-74	5	1.0	23	0.0435
75-79	2	0.4	13	0.0308
80-84	3	0.6	26	0.0231
85+	1	0.2	4	0.0500

Table 4.5 displays an abridged life table based on data gathered for Table 4.4. This table also includes the calculated probability of survival for each age range (S_x) (see Table 3.7 for Life table legend). The probability of survival is much lower for those under the age of one as infant mortality was notably high. Life expectancy at birth is 17.26 years.

Table 4.5

1881 Abridged Life Table (5 year intervals)

Age Interval	Rate of Dying	No. Living at Beginning at Year of Age	No. Dying During	No. Years of Life Lived by Cohort	Total person-years of life contributed	Avg. No. of years of Life Remaining	Survival Rate
(1)	(2)	(3)	(4)	(5)	(6)	(7)	
x to x+5	${}_nQ_x$	I_x	N_{dx}	${}_nL_x$	T_x	e_x	S_x
< 1	0.0350	100,000	3502	96,498	1,725,529	17.26	0.385
1-4	0.0065	96,498	625	95,873	1,629,031	16.29	0.994
5-9	0.0016	95,873	154	95,719	1,533,158	15.33	0.998
10-14	0.0009	95,719	91	95,629	1,437,438	14.37	0.999
15-19	0.0029	95,629	277	95,352	1,341,810	13.42	0.997
20-24	0.0036	95,352	341	95,011	1,246,458	12.46	0.996
25-29	0.0030	95,011	289	94,722	1,151,446	11.51	0.997
30-34	0.0025	94,722	233	94,489	1,056,724	10.57	0.998
35-39	0.0040	94,489	381	94,108	962,235	9.62	0.996
40-44	0.0021	94,108	202	93,906	868,127	8.68	0.998
45-49	0.0063	93,906	587	93,319	774,221	7.74	0.994
50-54	0.0081	93,319	752	92,568	680,902	6.81	0.992
55-59	0.0082	92,568	756	91,812	588,334	5.88	0.992
60-64	0.0184	91,812	1688	90,124	496,522	4.97	0.982
65-69	0.0302	90,124	2721	87,403	406,399	4.06	0.970
70-74	0.0435	87,403	3800	83,603	318,996	3.19	0.957
75-79	0.0308	83,603	2572	81,030	235,393	2.35	0.969
80-84	0.0231	81,030	1870	79,160	154,363	1.54	0.977
85+	0.0500	79,160	3958	75,202	75,202	0.75	0.950

Table 4.6 displays data gathered from the 1891 census and the frequencies of deaths in the records available from 1889 to 1893 which were used to calculate the death rate by age range. The death rate is still high for less than one year and declines before increasing slightly in the 15-19 year age range and peaking in the age range of 20-24. The rate peaks again for the age range of 35-39 year, dropping and then increasing to peak in the age range of 45-49 years. It drops again and peaks for age range 65-69. A larger leap in the death rate occurs between age

ranges 70-74 and 75-79 before declining. These increases and decreases are likely due to the small number of cases.

Table 4.6

1891 Death Rates

Age Interval	Number of Deaths between 1889-1893	Annual Average Number Deaths	1891 Census	Rate of Death
< 1	50	10	212	0.0472
1-4	25	5	896	0.0056
5-9	16	3	1101	0.0029
10-14	11	2	1047	0.0021
15-19	11	2	829	0.0027
20-24	21	4	749	0.0056
25-29	12	2	648	0.0037
30-34	7	1	457	0.0031
35-39	5	1	390	0.0026
40-44	8	2	309	0.0052
45-49	9	2	300	0.0060
50-54	3	1	263	0.0023
55-59	4	1	194	0.0041
60-64	9	2	144	0.0125
65-69	8	2	85	0.0188
70-74	5	1	60	0.0167
75-79	7	1	27	0.0519
80-84	3	1	13	0.0462
85+	1	0	8	0.0250

Table 4.7 displays the abridged life table developed from the data gathered for Table 4.6. This table also includes the calculated probability of survival for each age range (S_x). The probability of survival is only slightly lower for those under the age of 1 compared to 1881 as well as the other survival rates are displayed in Table 4.5. Life expectancy at birth is 17.13 years.

Table 4.7

1891 Abridged Life Table (5 year intervals)

Age Interval	Rate of Dying	No. Living at Beginning at Year of Age	No. Dying During	No. Years of Life Lived by Cohort	Total person-years of life contributed	Avg. No. of years of Life Remaining	Survival Rate
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	
x to x+5	$_nQ_x$	I_x	N_{dx}	$_nL_x$	T_x	e_x	S_x
< 1	0.0472	100,000	4717	95,283	1,712,954	17.13	0.380
1-4	0.0056	95,283	533	94,750	1,617,671	16.18	0.994
5-9	0.0029	94,750	275	94,474	1,522,921	15.23	0.997
10-14	0.0021	94,474	199	94,276	1,428,447	14.28	0.998
15-19	0.0027	94,276	250	94,025	1,334,172	13.34	0.997
20-24	0.0056	94,025	527	93,498	1,240,146	12.40	0.994
25-29	0.0037	93,498	346	93,152	1,146,648	11.47	0.996
30-34	0.0031	93,152	285	92,867	1,053,496	10.53	0.997
35-39	0.0026	92,867	238	92,628	960,629	9.61	0.997
40-44	0.0052	92,628	480	92,149	868,001	8.68	0.995
45-49	0.0060	92,149	553	91,596	775,852	7.76	0.994
50-54	0.0023	91,596	209	91,387	684,256	6.84	0.998
55-59	0.0041	91,387	377	91,010	592,869	5.93	0.996
60-64	0.0125	91,010	1138	89,872	501,859	5.02	0.988
65-69	0.0188	89,872	1692	88,181	411,987	4.12	0.981
70-74	0.0167	88,181	1470	86,711	323,806	3.24	0.983
75-79	0.0519	86,711	4496	82,215	237,095	2.37	0.948
80-84	0.0462	82,215	3795	78,420	154,880	1.55	0.954
85+	0.0250	78,420	1961	76,460	76,460	0.76	0.975

Table 4.8 displays data gathered from the 1901 census and the frequencies of deaths in the records available from 1899 to 1903 which were used to calculate the death rate by age range. The death rate is notably higher for less than one year (compared to Tables 4.5 and 4.7). It declines to the lowest point at 10-14 and stays relatively low before increasing at about 60-64.

Table 4.8

1901 Death Rates

Age Interval	Number of Deaths between 1899-1903	Annual Average Number Deaths	1901 Census	Rate of Death
< 1	88	18	226	0.0779
1-4	45	9	1154	0.0078
5-9	16	3	1285	0.0025
10-14	8	2	1201	0.0013
15-19	19	4	1109	0.0034
20-24	22	4	1066	0.0041
25-29	24	5	778	0.0062
30-34	17	3	666	0.0051
35-39	16	3	597	0.0054
40-44	13	3	465	0.0056
45-49	9	2	400	0.0045
50-54	8	2	302	0.0053
55-59	12	2	275	0.0087
60-64	14	3	256	0.0109
65-69	26	5	187	0.0278
70-74	26	5	122	0.0426
75-79	13	3	63	0.0413
80-84	18	4	34	0.1059
85+	14	3	19	0.1474

Table 4.9 displays the abridged life table developed from the data gathered for Table 4.8. This table also displays includes the probability of survival for each age range (S_x). The probability of survival is much lower for those under the age of one as infant mortality was notably high. Survival rates are lower than those displayed for 1881 in Table 4.5 and 1891 in Table 4.7. Life expectancy at birth is 15.7 years.

Table 4.9

1901 Abridged Life Table (5 year intervals)

Age Interval	Rate of Dying	No. Living at Beginning at Year of Age	No. Dying During	No. Years of Life Lived by Cohort	Total person-years of life contributed	Avg. No. of years of Life Remaining	Survival Rate
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	
x to x+5	$_nQ_x$	I_x	N_{dx}	$_nL_x$	T_x	e_x	S_x
< 1	0.0909	100,000	9091	90,909	1,569,806	15.70	0.362
1-4	0.0070	90,909	637	90,272	1,478,897	14.79	0.993
5-9	0.0027	90,272	248	90,024	1,388,625	13.89	0.997
10-14	0.0020	90,024	179	89,845	1,298,60 1	12.99	0.998
15-19	0.0041	89,845	369	89,476	1,208,756	12.09	0.996
20-24	0.0057	89,476	509	88,968	1,119,279	11.19	0.994
25-29	0.0067	88,968	597	88,370	1,030,312	10.30	0.993
30-34	0.0081	88,370	716	87,654	941,941	9.42	0.992
35-39	0.0070	87,654	613	87,041	854,287	8.54	0.993
40-44	0.0095	87,041	823	86,218	767,246	7.67	0.991
45-49	0.0060	86,218	515	85,704	681,028	6.81	0.994
50-54	0.0056	85,704	480	85,224	595,324	5.95	0.994
55-59	0.0072	85,224	615	84,609	510,100	5.10	0.993
60-64	0.0078	84,609	656	83,953	425,492	4.25	0.992
65-69	0.0346	83,953	2901	81,052	341,539	3.42	0.965
70-74	0.0500	81,052	4053	76,999	260,487	2.60	0.950
75-79	0.0556	76,999	4278	72,722	183,487	1.83	0.944
80-84	0.1250	72,722	9090	63,631	110,766	1.11	0.875
85+	0.2593	63,631	16497	47,134	47,134	0.47	0.741

Figures 4.1a and 4.1b display the distribution of demographic cohorts based on just the place of birth (Figure 4.1a) and the societal cohorts developed from the places of birth and death (Figure 4.1b). In both cases, *settlers* (nationally born) represent the largest proportion of individuals, while *immigrants* (global) represent the smallest. The societal groups (4.1b) reflect a larger portion of the data and is the variable of focus.

Figure 4.2 demonstrates the distribution of deaths by societal cohort from 1870 to 1936. Data are missing for the years 1909 to 1920 for all cohorts and the *band* cohort is notably under reported prior to 1900. Following 1921 *band* deaths increase considerably compared to *immigrant* and *settler* deaths. By 1935 only *settler* deaths appear to be increasing.

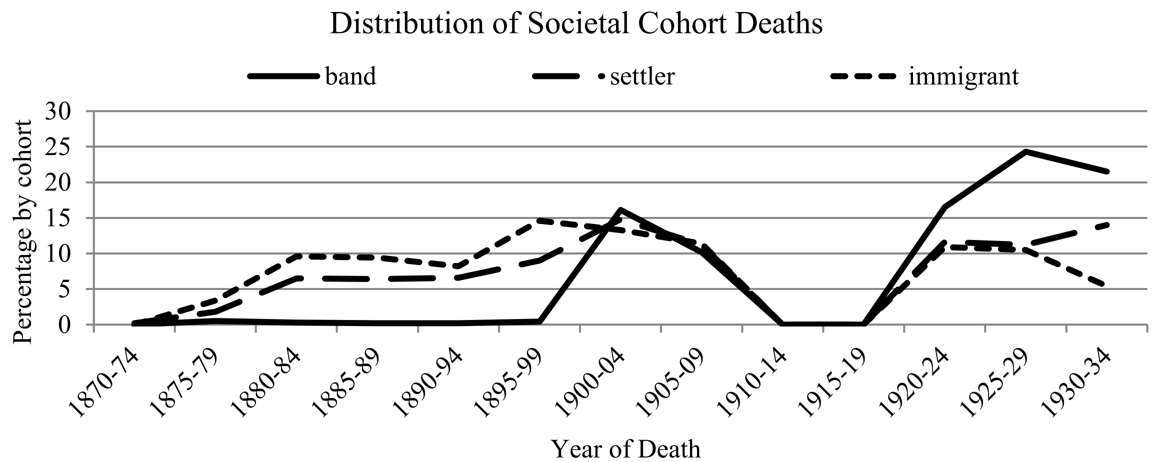

Figure 4.2. Distribution of societal cohort deaths (1870-1934).

Table 4.10 shows the number of males and females who died within each of the societal cohorts. There were a notable difference among *immigrants* with more male than female deaths. The *settler* cohort had slightly more male deaths while the *band* cohort had slightly more female deaths.

Table 4.10

Societal Cohort by Sex

	Band		*Settler*		*Immigrant*	
	N	*%*	*N*	*%*	*N*	*%*
Male	580	49.4%	1228	53.2%	345	64.4%
Female	595	50.6%	1080	46.8%	190	35.6%

Figure 4.3 shows the distribution of deaths by life stage from 1870 to 1936. Data are missing for the years 1909-1920 for all cohorts. All cohort deaths except the elderly peak between 1900 and 1904. Elder deaths peak in 1925 to 1929, while child and young adult deaths decline into 1930 to 1934.

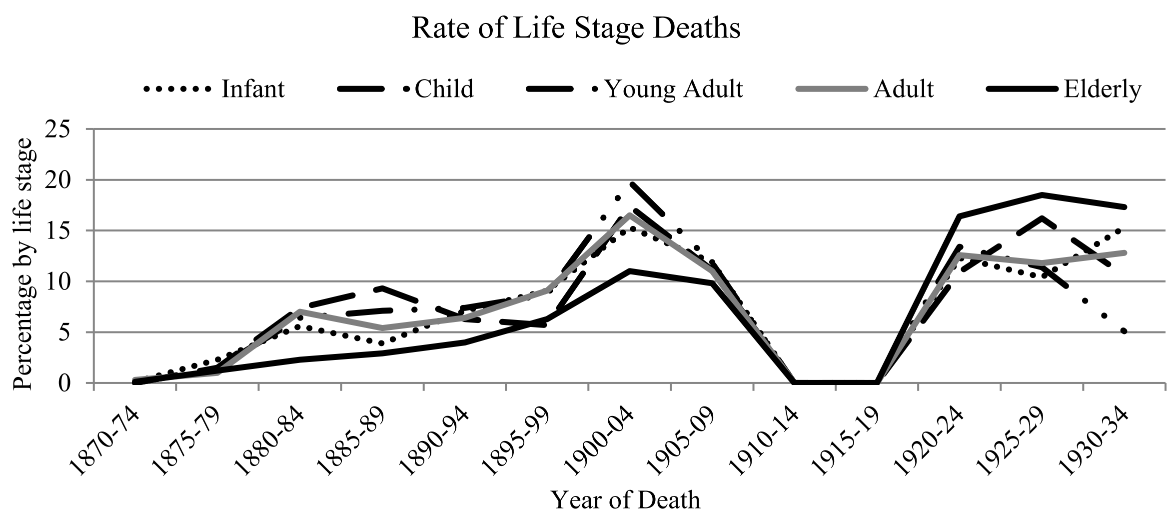

Figure 4.3. Distribution of life stage deaths (1870-1934).

Figure 4.4 displays the distribution of deaths by life stages across the societal cohorts. The life stages represent groups based on age at death (see Table 3.2). The *immigrant* cohort consists largely of elderly (age at death: 60+) deaths, followed by adult deaths (age at death 30 to less than 60), and few young adult (15 to less than 30), child (1 to less than 15) and infant (less than 1 year) deaths. The *settler* and *band* cohorts display similar distributions across the life stages – a smaller proportion of adult and elderly deaths and a larger proportion of infant, child, and young adult deaths.

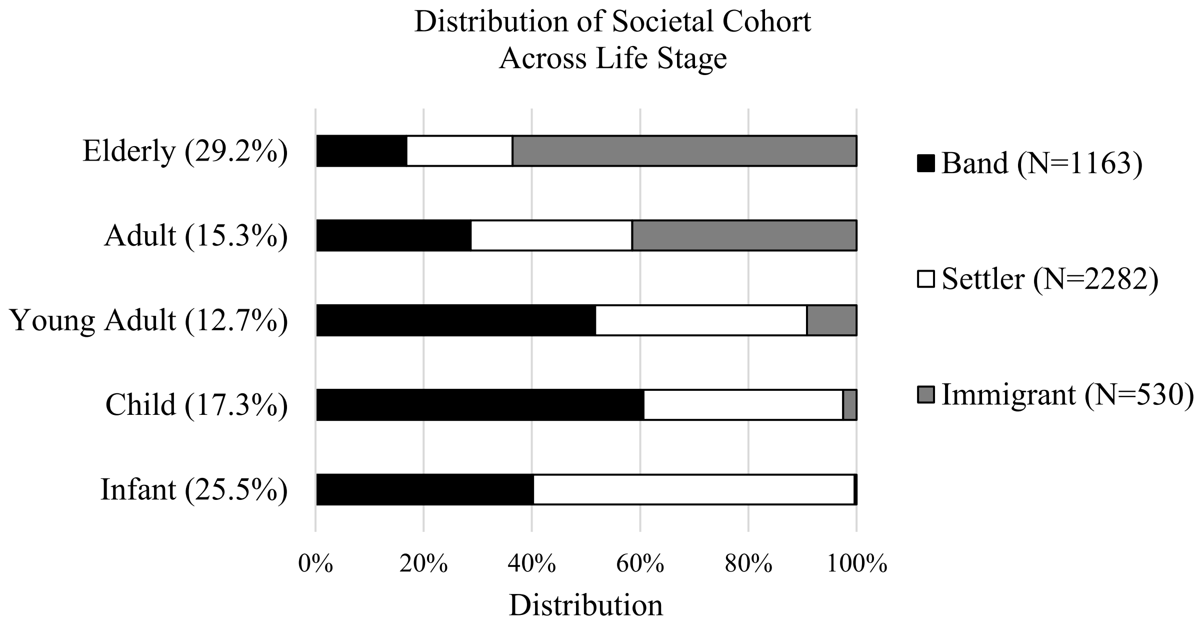

Figure 4.4. Distribution of societal cohort deaths across life stage age groups.

Figure 4.5 displays the results of a pairwise comparison of age at death by societal cohort that was performed, using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons, to compare ages at death. Statistical significance was accepted at $p < .05$. This post hoc analysis revealed differences in mean age at death between *settler* (mean rank = 17772.34) and *band* (mean rank = 1865.25) ($p = .049$), *settler* and *immigrant* (mean rank = 3190.18) ($p < .05$), *band* and *immigrant* ($p < .05$). The outliers present within the *immigrant* cohort are reflective of the small frequencies of infant, child, and young adult deaths.

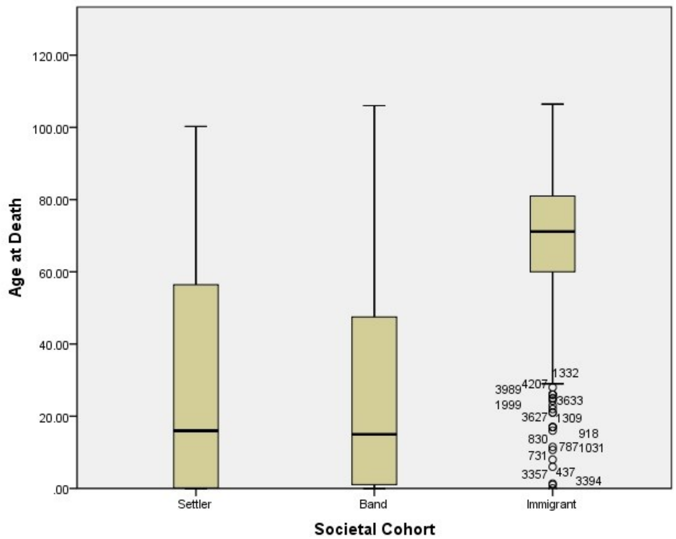

Figure 4.5. Distribution of societal cohort age at death.

Figure 4.6 shows the distributions of societal cohorts by place of death. (Place of death categories are described in Table 3.2). As societal cohorts are defined by places of birth and death, the *band* cohort is representative mostly of reserves. The south shore includes larger *immigrant* settlements as well as unorganised west with larger *settler* settlements.

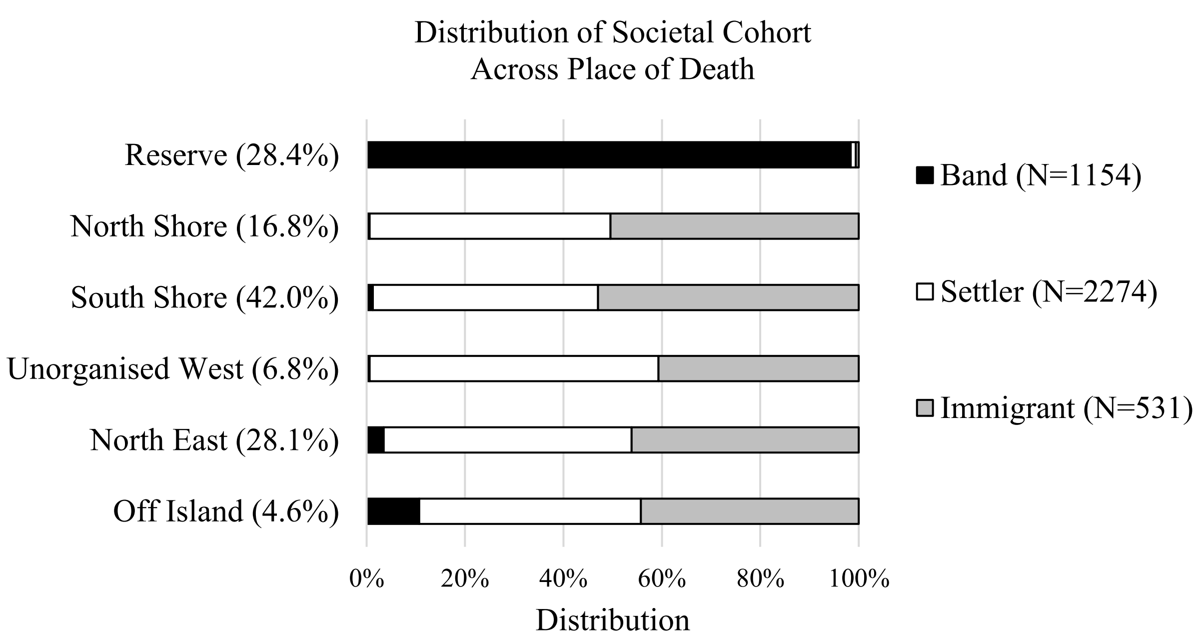

Figure 4.6. Distribution of societal cohort deaths across place of death.

Figure 4.7 depicts the distribution of primary causes of death by societal cohorts. The *band* cohort was notably impacted by respiratory and abdominal related causes; the *settler* cohort by infant-maternal, cerebrovascular, and deaths related to known infections; and the *immigrant* cohort by cardiovascular, and non-specific deaths.

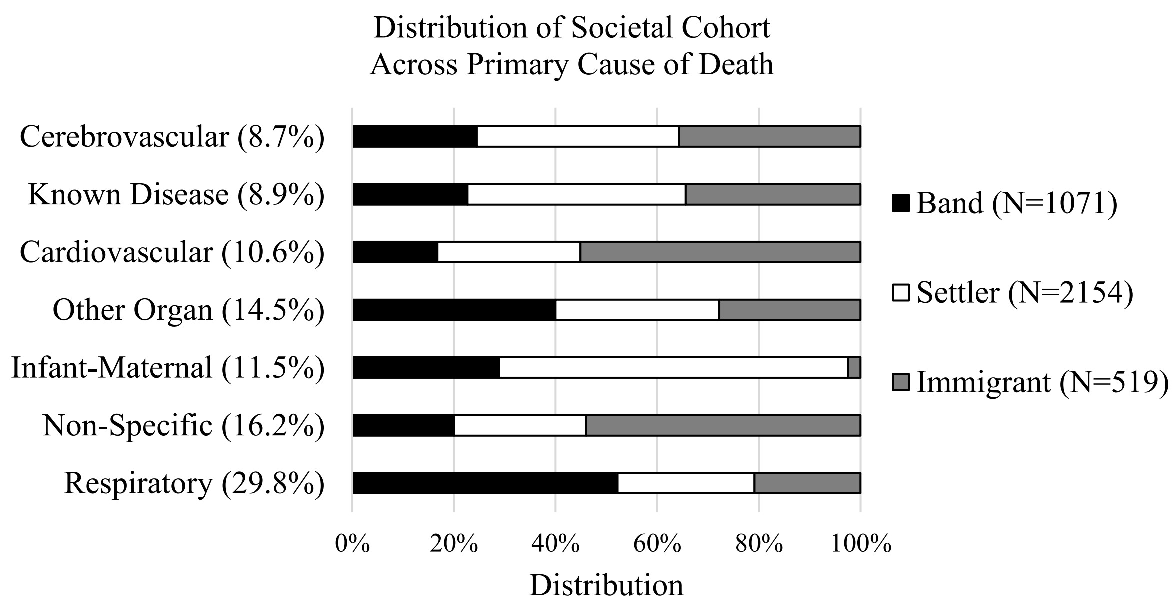

Figure 4.7. Distribution of societal cohort deaths across primary cause of death categories.

Figure 4.8 displays the distribution of male and female deaths by life stages. The statistical relationship between sex and life stage ($\chi^2(4) = 29.072$, $p < .01$) demonstrates a very weak association (*Cramer's V* =.083). Notable differences between sexes include slightly more female child, young adult and adult deaths, and more male elderly deaths.

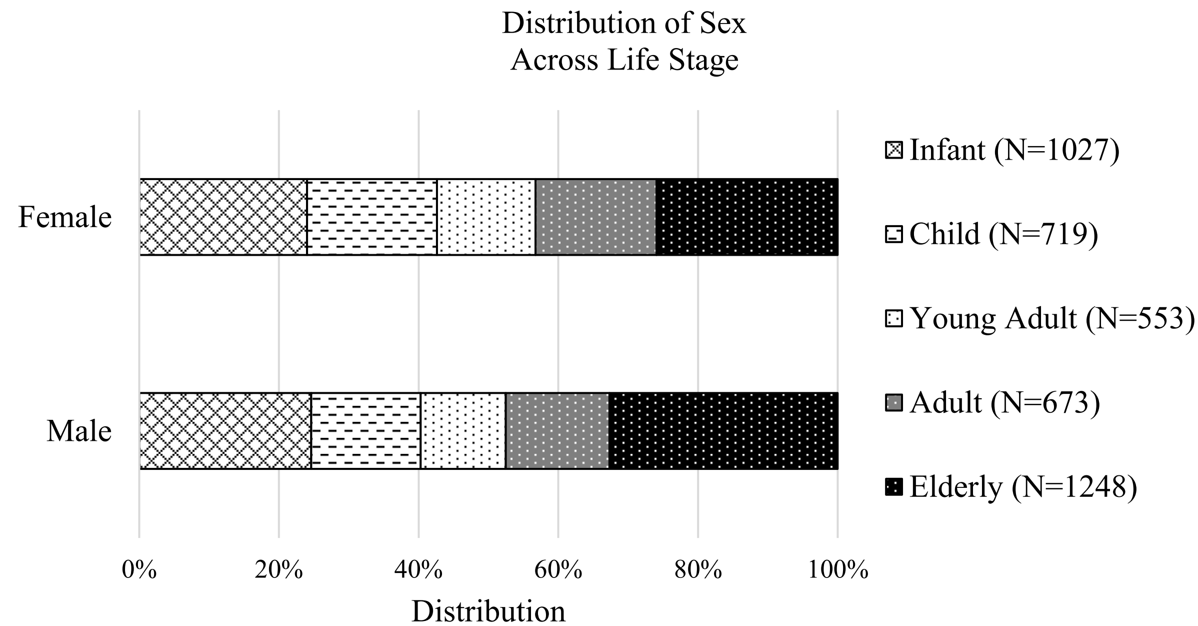

Figure 4.8. Distribution of deaths according to sex and stage in the life course.

Figure 4.9 shows the distribution of primary causes of death categories across the life stages. The statistical relationship between life stage and primary cause of death categories ($\chi^2(24) = 1935.275$, $p < .01$) demonstrates a strong association (*Cramer's V* =.350). Infant life stage deaths are consistent with the infant-maternal cause of death category that is related to pregnancy and childbirth complications. Elderly deaths are consistent with cardiovascular and non-specific deaths. Adult deaths are also notable with cardiovascular complications and known infections. Cerebrovascular complications are noteworthy for infant and elderly deaths. Digestive complications, categorised under abdominal origins are notable for child deaths. Other organ complications, also categorised under abdominal origins are more notable for deaths at older ages. Respiratory deaths are noteworthy for child, young adult, and adult deaths.

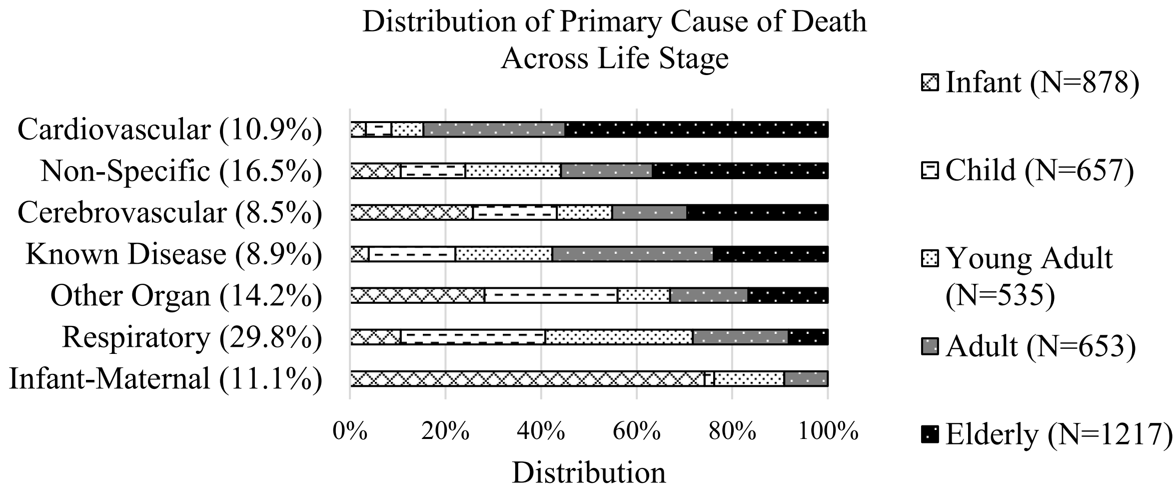

Figure 4.9. Distribution of primary cause of death across life stage age groups.

Figure 4.10 displays the distribution of primary cause of death categories by sex. The statistical relationship between sex and primary cause of death categories ($\chi^2(6) = 41.862$, $p < .01$) demonstrates a very weak association (*Cramer's V* =.102). Females are unsurprisingly more impacted by infant-maternal complications. Males and females are similarly impacted for known infections and respiratory complications. Males are noticeably more impacted by all other categories.

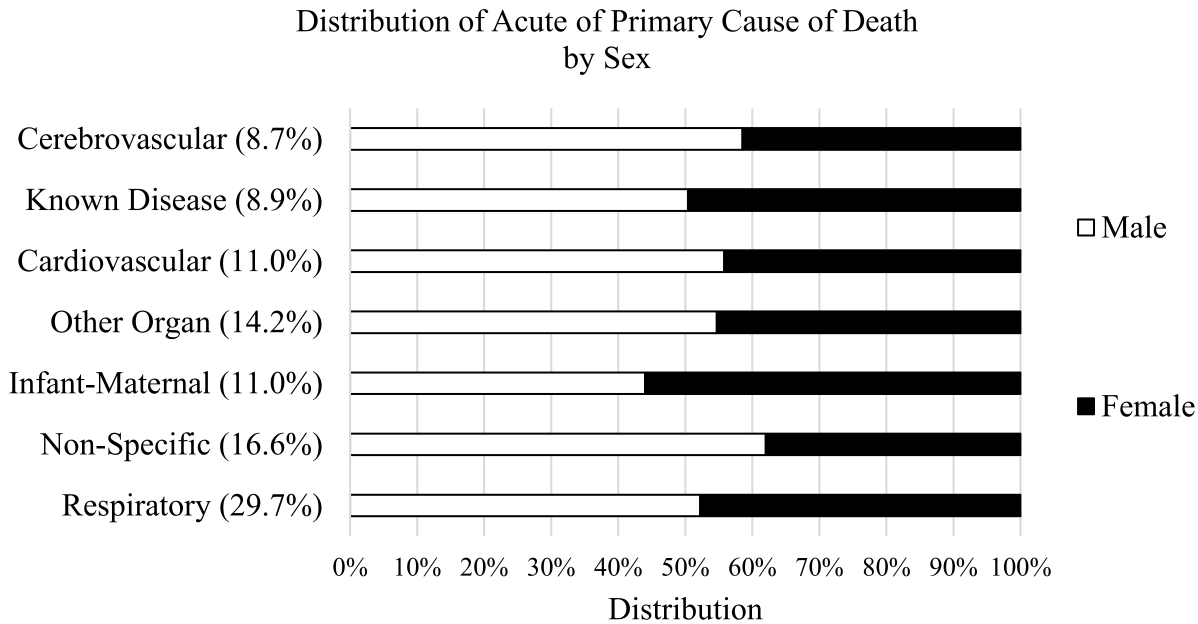

Figure 4.10. Distribution of primary cause of death by sex.

Figure 4.11 displays the distribution of infant mortality across specific ages of death. (Infants represent those aged 0, or stillborn to 0.99 or less than 1 year). Frequency of death was highest in the first week of life, dropping substantially by week two.

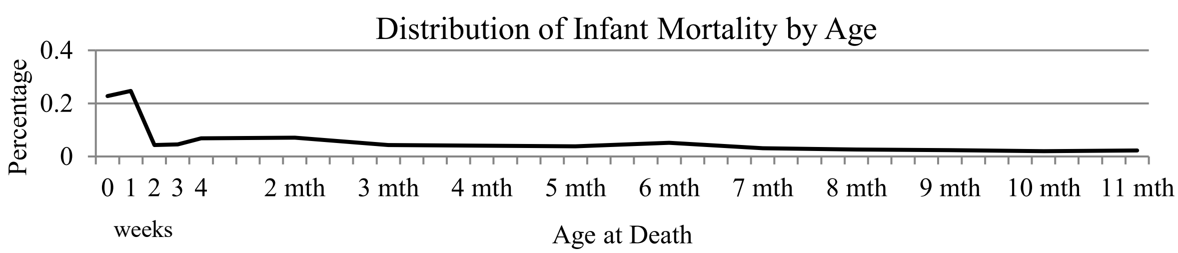

Figure 4.11. Distribution of infant mortality by age at death.

Table 4.11 displays the primary causes of death frequencies by season. The statistical relationship between season and primary cause of death categories ($\chi^2(18) = 90.721$, $p < .01$) demonstrates a very weak association (*Cramer's V* =.087). The majority of deaths occurred in the spring. Respiratory deaths, which is the largest primary cause of death category, display the greatest change in frequencies by season, with most deaths occurring in spring. Non-specific, infant-maternal, cardiovascular, and cerebrovascular deaths are also highest in the spring. Abdominal origin deaths and known infections have higher frequencies in autumn.

Table 4.11

Counts of Primary Causes of Death by Season

	Spring		Summer		Autumn		Winter	
Cause of Death	*N*	*%*	*N*	*%*	*N*	*%*	N	%
Respiratory (29.8%)	364	33.5	225	24.2	243	24.7	351	35.7
Non-Specific (16.5%)	191	17.6	156	16.8	166	16.9	144	14.6
Infant-Maternal (11.1%)	124	11.4	124	13.3	95	9.7	98	10.0
Other Organ (14.2%)	119	10.9	148	15.9	190	19.3	107	10.9
Cardiovascular (10.9%)	116	10.7	104	11.2	105	10.7	113	11.5
Known Disease (8.9%)	81	7.4	82	8.8	107	10.9	86	8.7
Cerebrovascular (8.5%)	93	8.5	91	9.8	76	7.7	85	8.6
Total	1088	100.0	930	100.0	982	100.0	984	100.0

Figure 4.12 shows the distribution of deaths by life stage and occupation. Occupation groups are defined in Table 3.3. This distribution only considers the older life stages of young adult, adult, and elderly (those whose age of death was at 15 or older). The *rank* group particularly considers those who may have still been considered too young to work or retired, as well as homemakers. The statistical relationship between life stage and occupation ($\chi^2(10) = 98.611$, $p < .01$) demonstrates a very weak association (*Cramer's V* =.148). The statistical relationship of sex as a control variable demonstrates a stronger association with males ($\chi^2(10) = 119.168$, $p < .01$; *Cramer's V* =.214) than females. The majority of the employed were *farmers* followed by *labour-trade* workers.

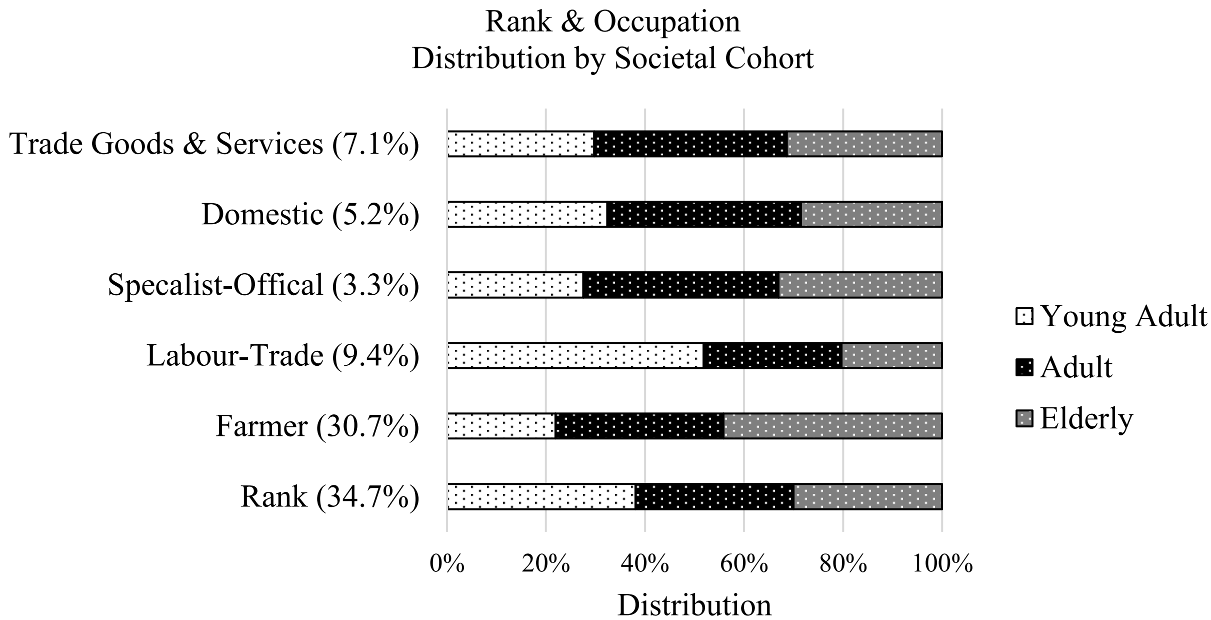

Figure 4.12. Distribution of occupation by life stage.

Table 4.12 displays the frequency of primary cause of deaths by occupation categories. The majority of deaths reflect the rank and farmer categories (see Table 3.3). The majority of infant-maternal deaths are attributable to the rank category and larger reflects housewives or young females. The majority of all occupation-related deaths are attributable to respiratory complications, except for the specialist-official occupation, the majority of which are attributable to cardiovascular complications.

Table 4.12

Primary Cause of Death Counts by Occupation

Primary Cause of Death	Rank	Farmer	Labour -Trade	Specialist -Official	Domestic	Trade Goods & Services
Respiratory (27.7%)	224	205	79	16	35	44
Non-Specific (21.3%)	156	164	66	16	22	41
Other Organ (6.9%)	48	61	20	5	6	10
Infant-Maternal (2.7%)	47	3	1	0	8	0
Cardiovascular (16.9%)	74	72	25	23	24	33
Known Disease (11.9%)	115	78	19	10	16	22
Cerebrovascular (8.6%)	132	132	11	5	9	17
Total	830	742	227	80	126	173

Table 4.13 provides frequencies that represent the main categories of death. The leading cause of death is attributable to pulmonary tuberculosis. Heart failure, lower respiratory tract infections (particularly bronchitis and pneumonia), and physical injuries reflect larger categorisations of more specific causes of death (see Table 3.5 and 3.6). These causes of death reflect almost half of the causes of death and largely reflect respiratory complications.

Table 4.13

Leading Causes of Death

Cause	*N*	%	Primary Cause of Death Category
Pulmonary Tuberculosis	499	12.5	Respiratory
Heart failure	386	9.6	Cardiovascular
Lower respiratory tract infection	344	8.6	Respiratory
Physical injury	240	6.0	Non-Specific
Stillbirth/premature	256	6.4	Infant-Maternal
Influenza	128	3.2	Respiratory
Stroke	113	2.8	Cerebrovascular
Sub-Total	1966	49.1	
Other Causes	2035	50.9	
Total	4001	100.0	

Table 4.14 displays the frequencies of specific tuberculosis related deaths by sex and life stages. Frequencies were highest for the young adult stage followed by the adult and then child. Deaths were also higher for females, except for the elderly category, which is higher for males.

Table 4.14

Tuberculosis Death Counts

	Infant		Child		Young Adult		Adult		Elderly		
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	Total
Male	5	1.0	43	8.6	96	19.3	67	13.4	20	4.0	231
Female	2	0.4	76	15.3	113	22.7	71	14.3	5	1.0	267
Total	7	1.4	119	23.9	209	42.0	138	27.7	25	5.0	498

Table 4.15 displays frequencies for other notable respiratory causes of deaths by sex and life stages. Deaths consistent with lower respiratory infections were higher for males, except for the child life stage which was higher for females. Deaths listed as influenza were higher for females, except for elderly which were higher for males.

Table 4.15

Lower Respiratory and Influenza Death Counts

		Infant		Child		Young Adult		Adult		Elderly		Total
Cause	Sex	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*
Lower Respiratory	Male	58	17.3	38	11.3	23	6.9	28	8.4	55	16.4	202
	Female	29	8.6	41	12.2	14	4.2	22	6.6	27	8.1	133
Total		87	25.9	79	23.6	37	11.0	50	14.9	82	24.5	335
Influenza	Male	9	7.2	13	10.4	3	2.4	7	5.6	26	20.8	58
	Female	11	8.8	19	15.2	10	8.0	8	6.4	19	15.2	67
Total		20	16.0	32	25.6	13	10.4	15	12.0	45	36.0	125

Table 4.16 displays the frequencies for the main causes by life stages within the cardiovascular primary death category. Frequencies were high for the adult life stage and notably higher for the elderly life stage for all causes.

Table 4.16

Cardiovascular Related Death Counts

	Infant, Child, Young Adult		Adult		Elderly		Total	
Cardiovascular Cause	*N*	%	*N*	%	*N*	%	*N*	%
Heart disease	8	1.9	28	6.5	72	16.7	108	25.1
Heart inflammation	16	3.7	17	3.9	88	20.4	121	28.1
Other complications	7	1.6	11	2.6	34	7.9	52	12.1
Heart failure	14	3.2	31	7.2	105	24.4	150	34.8
Total	45	10.4	87	20.2	299	69.4	431	100.0

Table 4.17 displays the frequency of main causes with the cerebrovascular primary death category by life stage. The majority of these deaths were attributable to the infant and elder life stages, by convulsions and strokes respectively.

Table 4.17

Cerebrovascular Related Death Counts

	Sex (*N*)		Life Stages (*N*)					Total	
Cerebrovascular Cause	M	F	Infant	Child	Young Adult	Adult	Elderly	*N*	%
Non-specific	27	13	16	11	8	2	2	40	11.5
Convulsions	55	42	61	19	6	7	0	97	28.0
Spinal/nerve	15	17	6	12	6	2	4	32	9.2
Paralysis/palsy	24	22	0	2	1	7	34	46	13.3
Brain disease	14	5	3	1	3	5	7	19	5.5
Stroke	68	45	2	0	0	17	92	113	32.6
Total	203	144	88	45	24	40	139	347	100.0

(M – Male, F – Female)

Table 4.18 displays the breakdown of specific causes of death within other known disease related deaths. These causes of death reflect other known diseases that can impact more than one region or bodily system (see Table 3.5). The most impactful was cancer which is broken down further in Table 4.18. Typhoid was noticeably more impactful among males and anemia among females.

Table 4.18

Known Disease Related Death Counts

	Male		Female		Total	
Known Disease Cause	*N*	%	*N*	%	*N*	%
Cancer	60	16.8	71	19.9	131	36.7
Typhoid	50	14.0	25	7.0	75	21.0
Anemia	22	6.2	33	9.2	55	15.4
Septicemia/shock	12	3.4	15	4.2	27	7.6
Streptococcal	13	3.6	10	2.8	23	6.4
Gangrene	10	2.8	7	2.0	17	4.8
Measles	5	1.4	10	2.8	15	4.2
Other	8	2.2	6	1.7	14	3.9
Total	180	50.4	177	49.6	357	100.0

Table 4.19 displays the breakdown of specific cancer deaths which are included within the primary cause of death *known disease* category. The proportions of males and females are representative of the frequencies for the primary cause of death. As expected, only females died of breast and cervical cancers, the same for a male and one case of prostate cancer. The majority of cancer deaths were upper abdominal (stomach, pylorus) and cervical, both impacting more

females than males. Lower abdominal cancers (intestinal, pancreatic, bowel, rectum, sigmoid) and bladder cancer reflect the majority of underlying causes of death; meaning it was not the immediate cause of death.

Table 4.19

Primary and Underlying Cancer Death Counts

	Primary Cause of Death				Underlying COD	
	Females	Males	Total			
Cause	*N*	*N*	*N*	%	*N*	%
Non-specific	*6*	*8*	*14*	*10.7*	*3*	*4.4*
Upper abdominal	23	10	33	25.2		
Bladder	2	4	6	4.6	12	17.9
Brain	1	1	2	1.5	1	1.5
Breast	7	0	7	5.3		
Cervical	16	0	16	12.2		
Cheek	4	2	8	6.1	1	1.5
Lower abdominal	6	9	15	11.5	37	54.4
Lower extremity (Leg)	1	2	3	2.3	10	14.7
Hodgkin’s & other glands	2	4	6	4.6		
Liver	8	4	12	9.2	4	5.9
Leukemia	1	0	1	0.8		
Lung	3	2	5	3.8		
Pancreas	1	1	2	1.5		
Prostate	0	1	1	0.8		
Total			131	100.0	68	100.0

Table 4.20 displays the breakdown of *other organ* deaths. The majority of deaths reflect complications that are more in line with infections contracted through diet and consumption of contaminated food supplies (Mercer, 2014). A smaller portion of deaths are attributable to overall digestive system infections or organ failures.

Table 4.20

Other Organ Complication Death Counts

Indirect Digestive Complications	*N*	%
Non-Specific inflammation of digestive tract	105	18.6
Constipation/Diarrhea/Cholera	122	21.6
Indigestion/Obstruction	88	15.5
Marasmus	38	6.7
Specific Organ Failures	N	%
Kidney complications /Diabetes	90	15.9
Liver complications	39	6.9
Other organ (appendix, bladder, gall bladder, prostate)	38	6.7
Bladder complications	19	3.4
Organ Tuberculosis	27	4.8
Total	566	100.0

Table 4.21 displays details about all of the individuals whose cause of death is listed as diabetes. The 21 entries (0.5% of the total population) are mostly *settlers* and males. Table 4.22 displays details about individuals identified as dying from other non-specific causes of death of which the underlying causes may have been the result of diabetes based on the literature regarding causes of deaths relating to diabetes (Mercer, 2014; Valenti; 2016). The majority of specific diabetes-related deaths are attributable to the *settler* cohort as well as possible diabetes deaths. The causes of deaths displayed in Table 4.21 reflect complications associated with diabetic related-deaths and are listed for both primary and underlying cause of death variables. A notable number of possible diabetes deaths are also displayed by the *band* cohort.

Table 4.21

Specific Diabetes Deaths

ID	Year of Death	Sex	Age at Death	Place of Death	Physician in Attendance	Societal Cohort
1	1880	M	23			Settler
2	1893	F	9	Gore Bay	J. Johnson	Settler
3	1895	F	25	Gordon	J. Johnson	NA
4	1896	F	58	Carnarvon	R. M. Stephen	Immigrant
5	1901	M	NA	Gordon	J. Johnson	NA
6	1902	M	69	Sandfield	J. McIntosh	Immigrant
7	1922	M	13	Barrie Island	J. A. Baker	Settler
8	1923	M	17	Wikwemikongsing	NA	Band
9	1925	F	84			Immigrant
10	1926	F	74			Immigrant
11	1929	M	15	Tehkummah	R. W. Shaw	Settler
12	1930	M	52	Gore Bay	F. A. Strain	Settler
13	1931	M	0	Tehkummah	R. W. Shaw	Settler
14	1931	M	34			Settler
15	1933	F	71	Burpee	F. A. Strain	Settler
16	1934	F	62	Little Current	C. R. Young	Settler
17	1934	F	70	Gore Bay	F. A. Strain	Settler
18	1934	M	73			Settler
19	1935	F	66	Robinson	J. A. Baker	Settler
20	1936	M	54	Mindemoya Red Cross Hospital	R.B. McQuay	Settler
21	1936	M	60	Gore Bay	F. A. Strain	Settler

57.1% males, mean age at death = 44.2, 66.7% settlers

Table 4.22

Possible Diabetes Related Deaths

Cause of Death	Complication	Settler	Band	Immigrant
Arteriosclerosis	Weakness/hemiplegia	17	9	6
	Myocardial	8	2	3
	Cerebral hemorrhage	10	2	2
	Nephritis	1	2	1
	Total	36	15	12
Gangrene	(= foot/leg)	9(=7)	2(=1)	5(=2)
Hemiplegia	General & uremia	14	3	2
	Myocardial	3	NA	NA
	Cerebral hemorrhage	2	NA	NA
	Total	19	3	2
Nephritis	General & uremia	14	8	1
	Cardiac complication	15	1	NA
	Total	29	9	1
Total	(% by cohort)	93(4.0%)	29(2.4%)	15(2.8%)

Table 4.23 displays the frequencies of deaths attributed to physical injury deaths within the primary cause of death category “non-specific” by sex and life stages. The majority of these deaths are consistent with drowning, followed by physical injuries, and fires. Other notable causes of death include train derailments, boat fires and boat sinking. Most drownings are attributed to the young adult life stage, physical injuries to elderly, fires to children, accidental gunshot wounds to young adults and adults; and involvement of alcohol to young adults, adults, and elderly.

Table 4.23

Physical Intervention Death Counts

		Sex		Life Stages*				
Cause of Death	*N*	*M*	*F*	Infant	Child	Young Adult	Adult	Elderly
Drowning	75	64	11	0	14	32	22	6
Physical injury	74	52	22	3	13	10	23	22
Fire	27	14	13	3	15	7	1	1
Accidental gunshot	19	19	0	0	3	7	8	1
Alcohol involvement	14	11	3	0	0	4	5	5
Suicide	10	8	2	0	1	1	3	5
Train accident	8	8	0	0	1	5	1	1
Poison	8	5	3	0	0	2	2	2
Murder	5	3	2	0	1	2	0	2
Total	240	184	56	8	50	70	65	45
% of Total		76.7	23.3	3.3	21.0	29.4	27.3	19.0

(*) Total percentage is calculated by 238 for life stage as two causes of death did not have a measureable age.

Table 4.24 displays the other causes of death, including physical injuries, categorised within the primary cause of death category of *non-specific* complications. The majority are reflective of the elderly life stage and are largely attributable to ‘old age’, followed by physical injuries (Table 4.22).

Table 4.24

Non-Specific Elderly Death Counts

Cause of Non-Specific death	*Infant*	*Child*	*Young Adult*	*Adult*	*Elderly*
Old age	0	0	0	0	171
Physical injury	6	50	68	63	47
Physical debility	30	2	0	11	45
Other muscular skeletal conditions	0	1	0	3	41
Non-specific inflammation and rupture	9	2	4	12	14
Total	45	55	72	89	318

Figure 4.13 depicts the distribution of primary categories by acute versus chronic causes of death. The statistical relationship between the primary causes of death and acute versus chronic complications ($\chi^2(6) = 1222.533$, $p < .01$) demonstrates a redundant association (*Cramer's V* =.618). The primary categories most associated with chronic, long term complications are cerebrovascular, cardiovascular, abdominal origins, and known infections. Conversely, infant-maternal deaths that represent child bearing and child birth are considered acute complications. Most respiratory related deaths are considered acute rather than chronic.

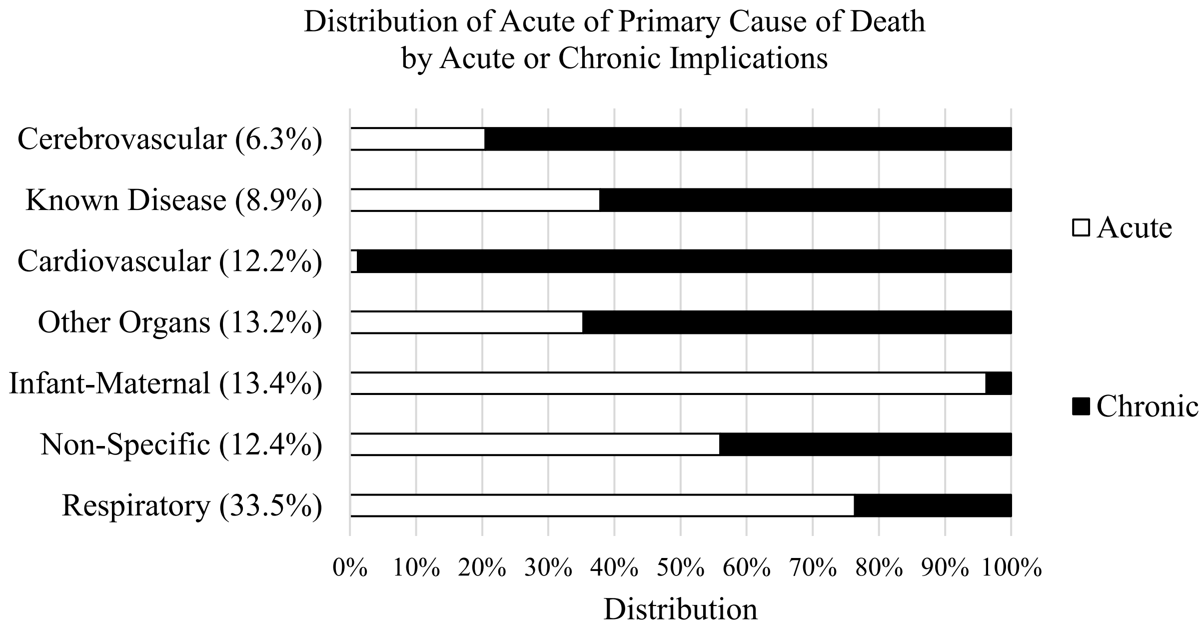

Figure 4.13. Distribution of primary cause of death by acute and chronic implications.

Figure 4.14 displays the distribution of acute-chronic implications by life stage. The statistical relationship between acute-chronic and life stage ($\chi^2(4) = 868.138$, $p < .01$) demonstrates a redundant association (*Cramer's V* =.524); redundant meaning both variables reflect the same distribution.

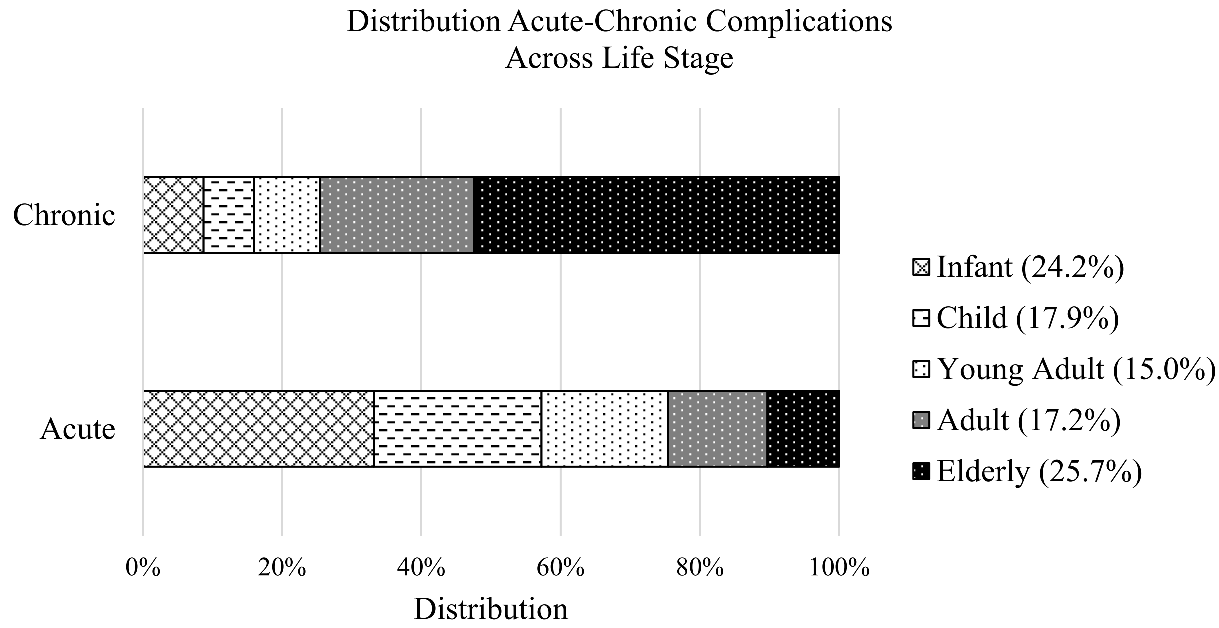

Figure 4.14. Distribution of acute-chronic implications by life stage.

Table 4.25 displays the frequencies of primary cause of deaths by region of death on the island. The statistical relationship between primary cause of death by place of death ($\chi^2(30) = 330.255$, $p < .01$) demonstrates a very weak association (*Cramer's V* =.130). Most deaths were registered as occurring in the North East and South Shore regions. Deaths occurring on reserves are comparable in frequency, but not geographically. Respiratory related deaths are noticeably much higher on reserves.

Table 4.25

Primary Cause of Death Counts by Region

Primary Cause of Death	Off Island	North East	Unorganised West	South Shore	North Shore	Reserve
Respiratory (29.0%)	62	211	54	230	106	477
Non-Specific (16.6%)	39	148	57	206	82	121
Other organs (14.3%)	26	109	33	132	83	180
Infant-Maternal (11.2%)	19	94	60	124	71	73
Cardiovascular (11.1%)	9	115	34	141	75	61
Known Diseases (9.0%)	16	94	13	116	55	59
Cerebrovascular (8.8%)	16	100	23	83	51	61
Total	187	871	274	1042	523	1032

CHAPTER 5. DISCUSSION

5.1 Introduction

Nancy Krieger (2001a) asks, "who and what is responsible for population patterns of health, disease and well-being as manifested in present, past and changing social inequalities in health?" (as cited in Krieger, 2001a, p.668). Health is most appropriately defined regionally by the way a particular community functions. This contextually-defined environment determines the patterns or trends that are seen in population health and are therefore subjective concepts that shift in reflection to societal functioning. It is the interacting risk factors of contextual societal environments that determine the regional variations of health, and result in trends seen within and between communities of a particular society. Mechanisms and interplay of societal variation across a subjective gradient such as health and disease are not easily conveyed in social (historical) epidemiology due to the interconnectedness of risk factors and multifactorial causation of disease, as well as the historical nature of the data (Krieger, 2001a; McLaren & Hawe, 2005; Mercer, 2014).

The intent of this study is to explore the eco-epidemiological findings of the analysis – that is, interpret the quantitative results of observable death trends considered within the contexts of the historical environment. The data mostly represent deaths on Manitoulin Island (Ontario, Canada) from 1870-1908 and 1921-1936. Unfortunately, considering the time period and the isolated nature of the region, the data is generally insufficient to calculate meaningful statistics. In light of this challenge, "epidemiologists must be more open to adopt creative study designs that tell compelling causative stories from associative data [as] an extension of social structure," (as cited in Lomas, 1988, p.1185). As such, this study relies on theoretical interpretations, historical accounts, and socio-ecological modeling to aid interpretation of the death trends and other observable trends in the data. Additionally, this approach was taken also due to the significant history the island has in the colonisation of Canada.

This discussion focuses on situating these data within an eco-epidemiologic interpretation that considers trends in death in relation to the contextual environment of historical Manitoulin Island. The 'distal and macro-contextual variables' from Defo's (2014) framework make visible intersections in contextual-environments that are underlying factors in disease pathways (see Figure 2.2). This study evaluates diseases impacts on a developing society through death records leading up to and following the turn of the 20th century, a period of notable societal transitions due to the unique population of the region. Analysis of these data in this case is thus heavily reliant on socio-ecological interpretations as they also explain data quality. Overall, the conclusions of how the contextually-defined environment impacts death trends may provide insightful connections regarding the multifactorial pathways of disease causation, ultimately contributing to the fragmented story of Canada's demographic and epidemiologic transitions.

5.2 Explanation of the Contextual Environment

According to Pío Jaramillo Alvarado, "to make a scientific study of man abstracted from the soil he cultivates, the landscape he travels, or the sea he sails is as impossible as understanding a polar bear or a desert cactus outside of their living mediums," (as cited in Marchesi, 2014, p.82). Contextual environments in all forms define the classification and understanding of societal functioning and provides the primary risk factors in exposure to ill health. As classifications are molded by environments, comparisons between two unlike environments makes uncovering meaningful connections difficult (McLaren & Hawe, 2005; Mercer, 2014).

The distal and macro-contextual variables outlined by Defo (2014) (see Figure 5.1) are first considered in terms of the underlying impact on the overall societal environment. The consideration of these variables is from an ecological perspective which suggests that all environmental intersections occur within the region of focus which in turn suggests that the *physical and climatic environment* (or PCE) is the foundational variable as everything happens though the physical environment (Tier 1). Next, the *historical and geo-political environment* (HGPE) must develop the *institutional environment and capacity of the collectivity* (IECC) with the *health systems and technology* (HST) which are the tools and resources that are available within the time period and physical region (Tier 2). Finally, the remaining variables: *cultural, social, and economic environments* (CSEE), *the demographic environment and pathology of the environment* (DEPE), and *preconceptional, conceptional, and multigenerational environments* (or PCME) reflect the outcome of other contextual intersections in terms of individual interactions (Tier 3).

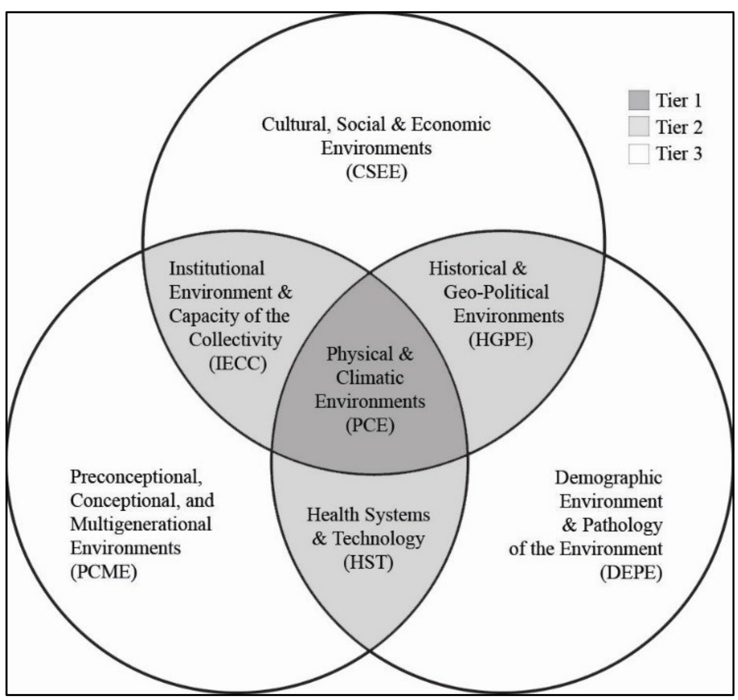

Figure 5.1. Defo's (2014) distal and macro-contextual variables re-understood.

This section specifically focuses on how in this study, the physical environment, PCE has a cascading impact on the contextual environment, specifically historical Manitoulin Island. The beginning of the records reviewed (1870) corresponds with the end of one era and the beginning of a new era for not only Manitoulin Island, but Ontario and Canada as a whole (McInnis, 2000a; Wightman, 1982). Many driving forces meant changes to a variety of environments that were influenced by geo-political demands and colonial hunger for land (Pearen, 2012; Wightman, 1982). In the 1860s, the island was impacted by the 1862 Manitoulin Island Treaty, which opened the island for immigration, the Confederation of Canada in 1867, and then the out-migration to the American Frontier which resulted in an economic depression by the early 1870s (to c.1876 in the region; to 1893 for the rest of Canada) (Barkin & Gentles, 1990; Gagan & Mays, 1973; Wightman, 1982).

The island itself was not set up for economic success. After it was opened for settlement, land surveys to define the boundaries of townships and property lines began (see Table 2.1). These surveys were carried out during the winter season when the environment was difficult to traverse; little consideration was given to the physical barriers of the terrain (Wightman, 1982). Karst land formations, spread across much of the island resulted in only small pockets of fertile land suitable for agricultural practices in the center region; the east end of the island was inhabited by the Indigenous people and remains unceded Indigenous land today (Enyedy-Goldner, 1994; McQuay, 2013; Pearen, 2012). Forests found between the pockets of arable land and rocks display diverse foliage, both new and old growth as a result of common forest fires (McQuarrie, 2006; McQuay, 2013; Wightman, 1982). The poor planning coupled with the geographic characteristics of the island resulted in the design of towns and townships that were not economically sustainable.

The first sale of land on Manitoulin Island was in 1866, but notable migration to the island did not occur until the late 1870s - early 1880s when much of the island was used for logging and there was a boom in the lumber industry on the shores of Lake Huron (Barkin & Gentles, 1990; Gagan & Mays, 1973; Pearen, 2012; Wightman, 1982). The end of sole inhabitancy by Indigenous People on Manitoulin Island, and the migration of immigrants and settlers to the island marked a significant end and a new beginning for the island.

Relations between the government and the Indigenous People as well as the isolation of the island made record keeping difficult. Not only was the island isolated from more urban centres of Ontario, but the island's west end was even more isolated compared to its larger urban centres (Gore Bay, Kagawong, Little Current, Manitowaning, Mindemoya, Providence Bay, and South Baymouth) that developed during this time period (Pearen, 2001; McQuarrie, 2006). This isolation was in part due to the larger distribution of karst land formations (Enyedy-Goldner, 1994; McQuay, 2013; Pearen, 2001). The island, despite its isolation from other urban centers, was easily accessible during the warm seasons via steamboats (McQuarrie, 2006; Pearen, 2012; Wightman, 1982).

The end of this era also coincides with the transition between the epidemiological transition 'ages' for the larger region (Ontario, Canada and United States northern border). Overall, the decline of infectious disease-related deaths during this period was coupled with the rise of degenerative and lifestyle-related diseases. As a result, infant mortality fell directly impacting rising life expectancies and declining fertility rates. This transition, between the ages of 'receding pandemics' and 'degenerative, human-caused diseases' is noted as occurring in North America from mid-19th century to c.1920 (Barkin &Gentles, 1990; Omran, 1977) and directly corresponds with the period of study from 1870 to 1936.

5.3 Evaluation of Data Sources

Defo's (2014) (Fig. 5.1) distal and macro contextual variable, the collective capacity (IECC), is used to understand the establishment of Manitoulin Island as a location for non-Indigenous settlements less than a decade before the period of this study. The interacting historical and political variables (HGPE) of the time are demonstrated through the idea that Manitoulin Island was not used to its full agricultural potential, resulting in the 1862 Manitoulin Island Treaty (Pearen, 2001; Pearen, 2012; Wightman, 1982). Logging in the region that occurred within the 1870s and 1880s led to increased industry as the space to establish farms and sawmills increased. The economy developed quickly and this space became populated with the working-class (McQuarrie, 2006; Pearen, 2012; Wightman, 1982). Census populations increased during this time span (see Table 4.1), suggesting an increase mainly due to migration.

Immigration in the region is documented as occurring from 1870 into the 1900s as Manitoulin Island was opened for settlement of non-Indigenous people in 1862. Migration occurred not only to the island from mainland Canada, but also from the mainland of the United States, the surrounding islands, and communities throughout the island (McQuarrie, 2006; Pearen, 2012; Wightman, 1982). The tourism industry, as well as the logging and fishing industries, had a significant impact on seasonal migration to Manitoulin Island and the surrounding region. For these reasons, as well as isolation and inaccessibility to remote locations of the island, inconsistent registration and data collection for the region resulted in an inaccurate representation of the population. Ontario's 1871 and 1881 censuses are considered by the registers and reviewers, as inadequate and are thus doubtful in their usefulness for reliable analyses (McQuillan, 1985).

When the population frequencies are compared to the available frequencies of deaths and births (see Table 4.2), it is apparent that the data from the births and deaths are under-representative. Comparing frequencies between the 1881, 1891, and 1901 censuses, in some cases the counts of births and deaths are fairly inconsistent between decades. The impacts of isolation and migration are known to play a role in under-representation. The majority of the townships that show the inconsistencies reflect the more unorganised, western, portion of the island: Allan, Barrie Island, Bidwell, Billings, Burpee, Campbell, Cockburn Island, Dawson, Robinson, and Sandfield.

Census, birth and death records reviewed in this study only extend to the 1911 census as death records are not available for unknown reasons between 1909 and 1920. This lack of data impedes the ability to explore the impacts of the significant political event, World War I, and the global outbreak of the Spanish Flu Pandemic; both events are known to have had an impact on the island's economy (Talbot, 2011; Wightman, 1982). This absence of data makes consideration of the deaths over time in the latter period (1921-1936) difficult to interpret in comparison to the deaths that occurred prior to 1909.

It is likely that the deaths of immigrants are the most accurately documented as their presence and process to obtain immigrant status was the most dutifully noted (registration in birth place, registration of transportation across seas and arrival in North America, likely settlement on mainland, and resettlement on Manitoulin Island). The place of birth data available in the death records was used to determine the portion of deaths that represent immigrants (see Figure 4.1a). Immigrants are one of three geographically delineated groups that represent separate and culturally defined cohorts or *societal cohorts* that were identified with the death records. Figure 4.1b displays these three groups based on the locations of birth and death: *band*

(Indigenous People associated with a known Indigenous community), *settler* (those born within North America, but not associated with an Indigenous community), and *immigrant* (those born overseas, particularly England, Ireland, and Scotland). Specific causes of death trends by societal cohort are discussed in section 5.5.

To determine the potential quality of census data between the 1881 and 1891 census for Manitoulin Island, a search of known immigrant registrations was performed. However, only a portion of individuals are traceable between the 1881 and 1891 censuses, 39.9% of males and 34.7% of females (see Table 4.3). Difficulties that contributed to tracing individuals included name changes (e.g. marriages), seasonal migration, and accessibility to the United States, all factors that contributed to the reliability of registration data (McQuillan, 1985).

Representing the immigrants and settlers of Manitoulin Island, abridged life tables (by 5 years of life intervals) were produced in order to consider mortality rates of a hypothetical cohort of 1000 people over their life time. The tables produced with the 1881 (see Tables 4.4 and 4.5), 1891 (see Tables 4.6 and 4.7), and 1901 censuses (see Tables 4.8 and 4.9) show some variation between the tables and within the life spans. The variations, particularly within the lifespans, reflect the poor data representation caused by the registration process and untraceable migration to and from the island; however, these variations are mainly the result of a lack of death registrations for the size of populations that are documented in 1871, 1881, and 1901. Despite the poor representation across the life course, the data do suggest a poor survival rate (at birth, expected to live 17 years, see Table 4.5 for example). The life expectancy in Canada in 1921 was recorded at 57.0 years for both sexes (Bourbeau & Ouellette, 2016; Canadian Human Mortality Database, 2014). In Toronto, Ontario in 1868 surviving to the age of five, meant living to the age of about 40.3 years. This life expectancy rose to 52.1 years by 1898 (Barkin & Gentles, 1990).

The diversity of the cultural representations is an important and defining factor of this study. The environmental and cultural contexts (CSEE) of three very different populations are certain to play a role in multifactorial disease causation (Defo, 2014; Krieger, 2001a; Mercer, 2014). Colonisation and the settlement of Manitoulin Island innately supported two of the groups more than the third. Through this marginalisation and discrimination, its social institutions come to define the main mechanisms at play in the societal interactions of these environments (CSEE) and therefore related health risks. The social and economic institutions during this time period were: natural resources, tourism, and business, which provided the base economy and employment; traditional medicine that was in competition with institutionally educated practitioners; politics, which defined the laws of societal organisation; and religion, which provided a sense of individuality and community (Derry, 2010; Liberatos, Link & Kelsey, 1988; Lomas, 1998; Navarro, 2008).

The impacts of the contextual environment are always intertwined with the *physical and climatic environment*. In this study, the location of the region was is in the middle of essential passage routes across the Great Lake system and the draw to natural resources and land exploitations were the driving factors behind political actions in accessing it. Both of these factors represent how the geo-political environment intersects with the physical environment. The physical environment defines the primary resource base upon which an economy is built. This is especially true in isolated and historical contexts which define accessibility and livelihood.

5.4 Evaluation of Societal Death Patterns

Consideration of the different cultures also adds depth to the analysis and interpretations of observable trends. Colonial relationships with the Indigenous People led to the development of deeply embedded distrust in registration of any kind; the problem was identified particularly in the region of Manitoulin Island (Pearen, 2012; Wightman, 1982). As a result of the 1862 Treaty, anybody was permitted to settle on the island; in contrast under the previous 1836 Treaty, the island had been promised solely to all Indigenous people who wished to move there. Both before and after the 1862 Treaty negotiations the island was promoted in tourism sections of newspapers not only in Ontario and North America more broadly, but also in Europe (Campbell, 2003; Pearen, 2012; Wightman, 1982). The romanticism in which the island was being presented attracted attention and helped to promote land sales describing Manitoulin Island, on the edge of wilderness as a desirable place to live (Campbell, 2003). This migration is reflective of the intersection between physical (PCE) and historical (HGPE) as well as the collective capacity (IECC) as developed through romanticised perception (PCME).

Figure 4.2 displays almost no band death registrations prior to 1900 while at the same time some settler and immigrant deaths. This lack of data is likely a result of Indigenous distrust of the governmental registration processes at that time and their consequent refusal to participate in documentation on Manitoulin Island (Pearen, 2012; Wightman, 1982).

The majority of immigrant deaths were male (64.4%) (see Table 4.10). This greater representation of male deaths likely indicates a larger proportion of immigrant males than females within the population. The literature supports this possibility as it describes how men would come to the island before their families to establish the homestead (Derry, 2010; McQuarrie, 2006). A higher proportion of male *settler* deaths (53.2%) may also suggest a similar situation. Deaths within the *band* group by sex reflect a more even distribution.

Deaths by age across the period of study (1870-1936) shows a steadier increase in elderly deaths leading up to the break in the dataset in 1909 (see Figure 4.3). The frequencies in adult and infant deaths also occur at a steadier increase. This likely reflects the period of adaption that follows the establishment of a settlement. Following the break in 1921, elderly death frequencies peak, while other age at death (lifestyle cohorts) ranges remain the same on decline, the latter attributable to young adult and child deaths.

Given that the *immigrant* cohort represents people who traveled a fair distance, often leaving their homes as mature adults in good health, it is reasonable that the cohort would be reflective of an older population at death. The data examined, shown in Figure 4.4, indicates this trend, with the *immigrant* group representing largely adult and elderly deaths. The settler group reflects a large proportion of infant, child, and young adult deaths, as does the band group. The higher representation of *settler-infant* deaths is likely linked with a higher possibility of having the death of an infant (particularly, stillborn and premature) registered.

Further, looking at the distribution of specific ages at death (see Figure 4.5) demonstrates similarities between the band and settler cohort. The settlers and band cohorts are similar in the sense that they both represent those born in North America, possibly having lived and died within the region. The figure displays different distributions in age at death for the immigrant cohort, while not surprising when taking into account contexts of migration and social oppression, it would be considered an interesting, abnormal distribution otherwise. The outliers represent those who died young within the typically older immigrant population.

The distribution of societal cohorts across the places of death (see Figure 4.6) demonstrates a slightly higher impact of immigrant deaths within the south-shore region. This is not surprising as this region includes the community of South Baymouth, a particular draw to Scottish fishermen, within the European settled township of Tehkummah (Derry, 2010; McQuarrie, 2006; McQuay, 2013; Pearen, 2001).

A similar deduction can be made about the slightly larger distribution of settler deaths within the unorganised west, a less accessible region (not only across the island, but via water such as the North Channel which was considered quite dangerous for boats) which included more locally settled communities such as Meldrum Bay (Derry, 2010; McQuarrie, 2006; McQuay, 2013; Pearen, 2001).

Sub-groups, particularly culturally defined, intersect differently within their contextual environments and therefore present with unique trends in health and disease accordingly. Observing these trends can provide insight into the understanding of various relations in terms of the risk factors within the contextual environments; however, this interpretation is difficult without first reviewing the overall trends in causes of death. It is through reflection of the different contextual environments, assisted by Defo's (2014) framework, that will best interpret the differences in causes of death between the sub-groups represented by the deaths in these data (see Figure 4.7).

Pathways of disease experienced by the band cohort (the Indigenous People), while present, are purposely reduced in the analysis and therefore the interpretation. Population data are the least adequate for this group and are considered ethically sensitive due to over-exploitation of Indigenous peoples in research.

The ideas put forth in this study reflect an analytical process which involves a certain degree of interpretation. As this study also takes into account the obvious gaps in the data, it therefore calls into question the overall reliability of the entire dataset to reflect adequate statistical interpretations. As a result this study focuses on the application of more socio-ecological, or theoretical, interpretations of the available data.

5.5 Evaluation of Cause of Death Patterns

In this analysis, cause of death was reviewed specifically with a biological system of focus. The method used for categorising the mostly non-specific causes of death was applied to best reflect the transient time in societal development, related disease impacts, and registration of data. This section reviews only observable trends of cause of death impacts in accordance with other non-culturally defining variables.

These trends however, do reflect the intersection between the demographic (DEPE) and cultural (CSEE) variables. Cultural differentiation, often perceived racially, defines sub-communities within a society as they are marginalised by the social and economic environments. The three societal groups that reflect different demographic and cultural backgrounds have different histories that resulted in their presence on Manitoulin Island. The variables of focus in this section evaluate other factors that relate to cause of death: age at death, sex, and economic lifestyles as reflected by occupation.

Within the contexts of the variable DEPE, certain trends of diseases are expected. Considering the migration to this location and quick development of society, it is expected that there would be notable increases in causes of death that are associated with the environment, such as increased infections caused by overcrowding and unsanitary conditions. This is expected to be most common in urban environments and found to typically impact vulnerable sub-populations the most, such as young children, the elderly, and the sick (Aber et al., 1997; Higgins, 2003; Lawn, Cousens, Zupan & Lancet Neonatal Survival Sterring Team, 2005; Ludlow, 2017; Sawchuck & Burke, 2003). Both the immigrants and the previous inhabitants are seen to experience a decline in health following the impacts of migration. The immigrants face barriers such as exposure to a new environment, adapting to a new environment, change of diet, and new risk factors (Ludlow, 2017; Sawchuck & Burke, 2003). These challenges reflect all of Tier 3 variables (Fig. 5.1) and therefore the other four embedded variables as well.

The impacts of migration and defined cultural differences represented within this dataset are reflected in age-at-death distributions which are noticeably different between sex and life stage (see Figure 4.8). The elderly, followed by infants, represent the age group with the highest proportion of deaths. This trend would generally be considered unusual as typically infants represent the largest portion of deaths for the time period and a rural context. Despite this, however, the life expectancy is still quite poor, as previously mentioned at 17 years at birth. For the region, the larger immigrant population with an older mean age at death contributed to this larger representation of elders. For this reason alone, more causes of death due to living longer than would be expected to be observable within this dataset (see Figures 4.9 and 4.10).

Children died particularly from causes of death due to respiratory complications and abdominal origins (such as diarrhea or marasmus) which is consistent with the contextual landscape – undernourishment weakens the immune system, and co-morbidity causes death (Rice, Sacco, Hyder & Black, 2000).

In general, infant survival for this time period was quite poor and slowly increasing (Omran, 1977). Infant mortality, in general, was highest in the first 24 hours and commonly attributed to infections and genetic causes (Lawn, Cousens, Zupan, & Lancet Neonatal Survival Steering Team, 2005; Wiley & Allen, 2013). Most infant deaths reflected in these data occurred in the first week of life (see Figure 4.11). There is only a slightly smaller portion of preterm deaths, death before birth (22.8%), than deaths within the first week (24.7%) of life.

Seasonality reflects an intersection between the PCE and the DEPE variables. Certain diseases present with observable cyclical trends (e.g. seasonally or yearly). Deaths in this dataset occurred most commonly (29.8%) in the spring (see Table 4.11), except for causes associated with abdominal origins and known infections. The warmer weather of summer may have contributed to unsanitary conditions and the survival of disease-causing microbes (Mercer, 2014) leading to an increase in mortality related to infections and digestive complications in the autumn. While some peaks in deaths due to diseases such as diphtheria or influenza appear before 1900, they are not discussed here in terms of outbreak potential as the data are insufficient to interpret.

The occupation variable provides further detail on lifestyle lived prior to death. Figure 4.12 displays the distribution of categorised occupations by the life stages of young adult, adult, and elderly. Only these life stage categories, 15 years or older at death, were considered as to encompass those who had an occupation. Individuals whom died under the age of 15 may have had a parent's occupation recorded. The majority of those in the young adult cohort were listed as rank (34.7%) (e.g., no occupation/student, homemaker, retired, etc., see Table 3.3) which likely reflected those who were still too young to work. Other rank deaths were female homemakers, or elderly and retired; living on an inheritance. The second largest portion is attributable to the farming occupation (30.7%).

According to the literature, the majority of skilled occupations were typically dependent on immigrants (McInnis, 2000b). In this study, these skilled occupations (e.g. bricklayers, painters, machinists) are categorised under labour-trade. The majority of those in labour-trades is attributable to the settler cohort (55.3%) whereas the immigrant cohort was more likely to be recorded as a farmer (33.2%). The majority of those identified as having a rank occupation is attributable to the settler cohort (62.6%). These percentages, however, are a reflection of the total portion of the occupation variable, which means that they do not take into consideration the societal cohort disproportions, a reflection of the under-reporting of population.

The majority of all occupation deaths were due to respiratory related causes (see Table 4.12) except those whose occupation was categorised as specialist-official (e.g., doctors, police, government officials, clergy), the smallest occupation category. The majority of causes in this category are attributable to cardiovascular related deaths. The majority of infant-maternal related deaths were attributable to rank category which likely reflects deaths of housewives due to prolonged labour or complications. These deaths also likely reflect more rural settlements and therefore an intersection between CSEE and HST.

About half of the available data represent leading causes of deaths (see Table 4.13). Many of these causes of death are related to respiratory complications. As noted in the literature, high rates of tuberculosis and unsanitary conditions are associated with increases in migration and overcrowding as well as impoverished living conditions. These rates are described as being even higher in Indigenous populations (Daschuk, Hackett & McNeil, 2006; Long, Njoo, Herfield;, 1999). Tuberculosis, also known to increase co-morbidity rates, dominates over other conditions and is likely to result in death. It is a known contributor to the 1918-9 Influenza pandemic fatalities which largely impacted young adults (Mercer, 2014; Young, 1988). Pulmonary tuberculosis contributed to 12.5% of the deaths in this analysis (see Tables 4.14 and 4.15) and was a leading cause of death. It is worth noting that 42% of these deaths are attributed to young adults, 27.6% adults, and 23.9% children. It is noted that the pandemic was spread by soldier returning home from war, the majority of which were young men (Talbot, 2011).

As the records are missing from 1909 to 1920, the effects of the influenza pandemic for the island cannot be commented on. Lower respiratory infections (8.6%) and influenza (3.2%)

were also contributors of respiratory complications that account for a notable portion of the overall deaths (29.8%, see Fig. 4.7, Fig. 4.9, and Table 4.8). Based on previous research, respiratory deaths were high for this time period (McInnis, 2000a; Omran, 1977) which is reflected in the data for Manitoulin Island.

Cardiovascular complications can be very difficult to decipher. Generally, heart complications are associated with chronic impacts that are suggestive of increased age, malnutrition, poor exercise habits, and other "unhealthy" addictions (Mercer, 2014). In the early 19th century, cardiovascular disease was considered a disease of the upper class (Lomas, 1988). Deterioration of the heart is now an associative symptom of earlier life exposure to infection (Mercer, 2014; Zuckerman, et al., 2014). While these pathways of disease causation are still considered chronic, this change in understanding creates confusion in the association of acute and chronic complications with infectious diseases (Mercer, 2014). This conundrum adds confusion to categorisation and even determination of environmental impacts on the multifactorial causation of cardiovascular complications and deciphering related causes of death trends, aside from the noted relationship to chronically defined complications.

The majority of cardiovascular complications in this dataset (see Table 4.16) are observed, not surprisingly, within the elderly life stage (69.4%) followed by adults deaths (20.2%). While there is a larger impact due to heart failure and heart inflammation reflected in these data, it is difficult to comment on any other contributing factors to these non-specific causes of death. The underlying condition is undeterminable as it involves too many complex risk factors. In contrast, cardiovascular deaths occurring at younger ages are more likely attributed to chronic malnutrition or genetic defects (Mercer, 2014). The frequencies are low for the infant, child, and young adult groups (10.4%) in terms of deaths related to cardiovascular complications and are most associated with heart weakness and inflammation.

Cerebrovascular complications (brain, spinal, and nerve), like cardiovascular conditions, are difficult to comment on due to multifactorial causations of unspecifiable conditions resulting in the cause of death being recorded as a non-specific symptom. Overall, deaths attributed to strokes reflect 2.8% of total deaths (see Tables 4.13 and 4.17). The elderly, particularly males, were affected the most by cerebrovascular related deaths, of which most were strokes. Infant deaths are also noticeably high in this category; the highest frequency attributed to convulsions, a common non-specific infantile death for the time period (Lawn et al., 2005; Mercer, 2014; Walker & Johnson; 2003).

The majority of deaths in the known disease category (see Table 4.18) are cancer related (see Table 4.19). Most frequent were cancers of the upper abdominal organs (33 deaths) such as the stomach and intestine. A notable number of cervical cancers (16); lower abdominal (15) and liver cancers (12); and underlying lower abdominal (37) and bladder cancers (12) are represented in these data as well. Cancer is commonly noted as an underlying cause of death, which suggests its connection to numerous lifestyle behaviours such as malnutrition, alcohol consumption, smoking, high body-mass index, other diseases, and exposure earlier in life (e.g. increase in pollution from industrial revolution, infectious diseases) (Forouzanfar, et al., 2016; Mercer, 2014) as well as a degenerative disease (Mercer, 2014; Omran, 1971). On Manitoulin Island, it is plausible that many of the cancer deaths are attributable to lifestyle factors. Alcohol consumption stands out among the risk factors for this location, not only documented within the literature (Derry, 2012; McQuarrie, 2006), but represented with specific causes of death within this dataset as well. It is plausible to suggest a notable impact of the variable CSEE (cultural, social, and economic environments) on cancer deaths.

Complications of lifestyle factors are also reflected in deaths relating to other organs (see Table 4.20). Many factors in this region, such as isolation, inadequate farming capabilities and yields, restriction of practice of certain cultures and reduction in hunting territories as well as introduction of new foods, and decline of country food supplies, contributed to malnutrition (Derry, 2010; Pearen, 2012). Other factors, such as constipation, diarrhea and cholera (122 deaths, 21.6% of cause of death category) and non-specific inflammation (105 deaths, 18.6%) likely are the result of underlying bacterial or parasitic exposure (Mercer, 2014; Rice, et al., 2000; Sawchuck & Burke, 2003). Like respiratory, abdominal complications can also cause noticeable impact in co-morbidity and on vulnerable populations. Both complications also display seasonal trends (see Table 4.11).

Respiratory related deaths peak in the spring, consistent with the intersection of the pathology of the environment (DEPE). Risk factors that contribute to the spread of respiratory diseases in the spring time include, but at not limited to: the winter-melt, spread of pollen, lack of resources used over winter, succumbing to co-morbidity of disease impact experienced through the winter as the cold exacerbates respiratory diseases (Derry. 2010; Mercer, 2014). Other organ deaths peak in the autumn and this also reflects the pathology of the environment. The hot, summer environment exacerbates the spread of microbial and parasitic diseases which like respiratory deaths causes an increase in mortality the following season (Mercer, 2014; Rice, Sacco, Hyder & Black, 2000).

Non-specific factors that have already been attributed to cardiovascular complications, known infections, or kidney complications could be obscuring the underlying cause of diabetes, which is known to be diagnosable and present on the island during this time period. Specific deaths attributed to diabetes first appeared in 1880 (see Table 4.21). A variable available in the death dataset, physician in attendance, was reviewed for specific diabetes cause of death only. The table indicates that there were specific reoccurring doctors by region and time period that were able to diagnose diabetes as an impact in death.

Complications of diabetes can be associated with causes of death such as anemia (septicemia), arteriosclerosis (hardening of the arteries), cardiac asthma, atrophy, weakness, gangrene of the foot/leg, hemiplegia, and/or any combination thereof (Mercer, 2014; Valenti, 2016; WHO, 2013). The impacts of these causes of death observed within this dataset are displayed in Table 4.21, the main impact of co-morbidity being arteriosclerosis followed by hemiplegia. The impact of diabetes is likely much larger than represented by these specific deaths, considering the impact today (Valenti, 2016). These impacts are represented in this dataset under cardiovascular and cerebrovascular complications, other organ complications, and known diseases. In other literature, a rapid increase of diabetes is recorded as occurring in the late 19th century and attributed to rapid social and dietary changes; hence, prevalence is expected among Indigenous People (Dobson, 2012; McInnis, 2000b; Tjepkema, 2002; Valenti, 2016).

Deaths resulting from physical injury contribute to 6% of overall deaths (see Tables 4.13, 4.22, and 4.23), the majority attributed to drownings and unspecified accidents. Certain events, such as the sinking of the *SS Asia* in 1882 (Campbell, 2003; Pearen, 2001; Wightman, 1982) contributed to many of these deaths. A hundred and thirty-two people died in this incident, but only a few are explicitly noted within the Manitoulin death records. One man was recorded as having died in 1921 due to a gun shot. In the notes it was written that he had been "found during the war." This man did not likely die, in 1921 and had been a soldier during World War I. It is plausible that other records of deaths from the missing time period (1909-1920) are recorded under an incorrect year.

An important consideration in the transition between the epidemiologic ages is the increase in life expectancy which suggests causes of death transitioning from being impacted mostly by acute infectious, to more chronic, long-term degenerative complications. The records were coded based on the information available (including duration of illness) to classify deaths as either acute or chronic. This variable was used to explore the trends of acute and chronic causes attributed to this dataset. Unsurprisingly, certain causes are associated with more chronic complications (cardiovascular, cerebrovascular, and abdominal origins) (see Figure 4.13). A shift from acute to chronic conditions is noticeable between the young adult and adult life stages (see Figure 4.14), which is consistent with living longer. These causes of death trends reflect intersections in the contextual environments. The impacts of in-migration result in a larger proportion of older ages at deaths and therefore more chronically defined degenerative conditions.

5.6 Evaluation of the Epidemiologic Transition

As the physical environment varies regionally so do all the factors that are defined by it. The DEPE variable defines global variation and is what reflects the eco-epidemiologic approach in understanding disease trends. More so historically than in present times, demographic regions can reflect cultural representation thus intersecting with the variable CSEE. The historical representation also defines the region's access to health and technology (HST) which historically would have been limited (tier 3 variables, Fig 5.1.).

It is apparent that this dataset reflects at least two separate population groups on Manitoulin Island during the time frame of study, representing different points in the epidemiologic transition. The interpretation of this however, requires the reflection of socio-ecological approaches that examined the impact of specific known causes of death. Respiratory complications such as tuberculosis, pneumonia, and influenza; chronic complications such as heart disease, stroke, old age, and diabetes; and causes of death reflecting the immediate physical environment such as drowning and physical injury, all tell compelling causative stories that implicate the epidemiologic transition age.

Immigrants, or those born outside of North America, represent an older cohort due to travel distances and time between birth elsewhere and death on Manitoulin Island. It is therefore not surprising that they represent a noticeable proportion of the adult and elderly groups, and the commonly age-related causes of death: cardiovascular complications, strokes, old age, chronic complications, and other non-specific muscular-skeletal complications.

The settler group, those born in North America and not associated with an Indigenous community, represents notable trends in all age cohorts. In particular, females and infants were impacted by infant-maternal complications, and deaths related to stillbirths, premature births, and other childbirth complications (particularly long duration of labour).

The Indigenous People who largely reflect the band population are excluded from this section of the discussion. This data is recorded as the most under-representative of all. Prior to 1900 there is also not data attributable to the band cohort in the death records. The data presented in previous sections are publically accessible and provide an important perspective of the contextual representation of Manitoulin Island. Interpretations made here would likely be skewed.

Settler adults were also affected by cardiovascular complications and specific infection related causes, both of which are also consistent with chronic complications. It is plausible to consider the role of the HST variable in the deaths due to known infections as access to medical-aid as a risk factor. Individuals of the working class would often have to carry on despite maladies (Derry, 2010; McQuarrie, 2006; Mercer, 2014), maintaining the mentality that they should just carry on as there was work to be done. These maladies could lower the immune system leaving the individual open to co-morbidities and cause other chronic complications resulting in death. These causes of death suggest intersections with the PCME variable as they reflect how one may have perceived their condition.

Settler children, young adults, and adults were noticeably impacted by respiratory complications, specifically tuberculosis, and lower respiratory complications; children were more subject to upper respiratory complications. Respiratory complications also impacted the other societal cohorts within the same age ranges. These causes of death reflect the *pathology of the environment* as respiratory infections were generally commonplace before and after the 1918-1919 influenza pandemic.

Some settlers are identified has having died of diabetes mellitus, or complications that suggest diabetes. Diabetes type 2 was more likely the cause of older age-related diabetes deaths. As a disease that is associated with chronically poor nutrition, it is surprising that there were not more directly related diabetes deaths. Into the 20th century it was a leading cause of death noted in the Ontario census (McInnis, 2000b). This disease in particular reflects an intersection between the PCE and CSEE variables as it is determined by what foods were available. This intersection also reflects other complications caused by poor nutrition. Diabetes as a specific cause of death is represented by HST as the disease was likely underrepresented due to misunderstandings and misdiagnoses.

The PCE variable intersecting with the PCME variable reflects the deaths where the physical environment is a driving risk factor. The immigrant population was likely the least experienced cohort in their perception of environmental hazards. Settlers, in comparison, likely had greater exposure through their upbringing in rural environments possibly similar to Manitoulin Island. Despite the differences, both cohorts were impacted by deaths resulting from physical intervention. This is another example of the intersection between the PCME and PCE.

The macro-contextual variable from Defo's framework, HST is important to consider as it encompasses defining factors previously stated in social epidemiological models. The HGPE variable suggests low access to and/or knowledge of health tools and treatments. The high infant deaths for this time period observable on Manitoulin Island reflect the interaction of the DEPE variable which remained high, not declining until after the 1920s for urban North American locations (Omran, 1977) and likely for Manitoulin Island as well. Respiratory and digestive complications were extensive due to low immunity caused by the urban environments (such as Little Current, Gore Bay, and the South Shore) perpetuated by aspects of lifestyle including over-crowding, poor nutrition, and poor sanitation. Lowered immunity is associated with a greater susceptibility to respiratory and digestive complications that lead to co-morbidity, particularly in vulnerable sub-groups (e.g., infants, elderly, Indigenous Peoples) (Mercer, 2014; Omran, 1971; 1977).

While it is difficult to interpret death records from any population due to the complex understandings of disease and societal intersections, this representation of an eco-epidemiological explanation of death records from Manitoulin Island, 1870-1908 and 1920-1936 can be considered as representative of Omran's (1971) 'age of receding pandemics' and the transition to the 'age of degenerative, human-caused diseases.' This conclusion or observation is consistent with other nearby regions that reflect the transition to have occurred about this time period (Barkin & Gentles, Gagan & Mays, 1973; 1990; Omran, 1977). However, as this dataset reflects migration from locations “further along” in the epidemiologic transition, these data also represent death trends associated more with the third age therefore possibly misrepresenting the advancement of the transition specifically in this region.

The most impactful cause of death, however, was respiratory complications, with tuberculosis being the largest cause of death over all (29.8% and 12.5% of deaths respectively). In 1866, Toronto, pulmonary tuberculosis was the leading cause of death, reported as 26.2 per thousand (Barkin & Gentles. 1990). However, tuberculosis can become exaggerated by other infectious complications (Ludlow, 2017) and can lay dormant for many decades, causing other chronic complications (Mercer, 2014). It is noted in the literature that the impacts of tuberculosis during this time period may have been exaggerated due to misdiagnosis (McInnis, 2000b).

Manitoulin Island played an important and significant role in history, during the colonial era and the transition into the modern, industrial era. This closure or transition aligns with the change in epidemiologic ages, supporting the undeniable impact contextual-environments have on disease processes even in small and not well established population registries. It is important to consider ecological aspects in combination with epidemiological processes in order to understand the regional differences between comparable studies. A lack of consideration of specific environmental factors in this analysis, such as the impact of migration, the unreliability of 1871 and 1881 censuses, and the impact of colonial history and romanticism that was applied to the region would result in an inaccurate representation of reasons driving certain death trends. As the reviewer, it is essential to explicitly consider the contextual environments in relation to cause of death, especially in the region where they play such a defining role in the observable trends.

5.7 Limitations and Future Work

Despite a notable gap in the dataset for reasons unknown extending from 1909 to 1920 (only 10 entries recorded), this study provides a stepping stone upon which more in-depth studies could build. This gap coincides with World War I and the Spanish influenza pandemic. Initially inconsistent documenting of records in Canada improved overall in quality towards the turn of the century, as registration processes were refined and were uniform by 1931. Migration, isolation, and Indigenous relations all played notable roles in the recorded history of Manitoulin Island. The overall inconsistency of these data limits the possible statistical analyses that could have been conducted.

There are a number of opportunities in building on this research. It would be beneficial to investigate the reason for missing data between 1909 and 1920 and how this impacts understanding in causes of death before and after this time period. A more direct microbial understanding of disease processes would be useful in the interpreting of death trends, especially in illumining the relationship between infectious diseases resulting in acute and chronic complications of non-specific deaths. Consideration of other data sources such as journals, burial records, obituaries and other documents would support more qualitative studies and would certainly benefit a better understanding this population data.

Further, more specific research interests with this dataset may include exploration into the Anglophone and Francophone differences in fertility and mortality. Manitoulin Island was initially established by the French and throughout development there was a clear difference between English or Protestant settlements on the island and French or Roman Catholic settlements. Further exploration of death impacts regarding the Indigenous data would also be possible despite poor quality data. Impacts of cancer-related deaths in this dataset may be of particular interest. Again, this would likely take a more socio-ecological perspective which is, however, more in line with holistic research processes used by Indigenous researchers and that ultimately should include and reflect local perspectives.

5.8 Conclusion

"Epidemiologists must be more open to adopt creative study designs that tell compelling causative stories from associative data [as] an extension of social structure" (Lomas, 1988; 1185). Different societal transitions (demographic and epidemiologic) occur as intersections in the contextual environments that shape and define growth and development. Cumulative knowledge and technology bring about influential changes that result in global shifts. As major societal shifts occur so do shifts in health impacts. These societal advancements are controlled by separate forms of governance, so comparing different settings and developing overarching truths regarding the causation of disease without considering contextual health risk factors is limiting.

The location of study, Manitoulin Island (Ontario, Canada), is historically wrought with geo-political attachments to the physical landscape, representing an intersection between Defo's (2014) distal and macro-contextual variables: *physical and climatic environment* (PCE) and *historical and geo-political environment* (HGPE). Its location, within Lake Huron, became the center of attention, and was perceived as having numerous opportunities to control the Indigenous populations. In 1836, Manitowaning, a community on the island, became the site for the political 'distribution of gifts' and then in 1836, the island itself was turned into or what was hoped it would become, a "Great Indigenous Reserve." Both actions reflect ideals based in romanticism, a cultural perception of attaching peaceful and loving value to a particular landscape. Romantic motifs were attached to Indigenous peoples since first contact and became embedded into the Canadian literary form and therefore its identity, in part due to the greater region that includes Manitoulin Island. Political officials were of the mind that moving Indigenous People away from the increasingly growing settlements where they would not be "in the way" was allowing them to continue to live their lives undisturbed; however, they hoped the majority would flock to Manitoulin Island and settle into agricultural communities.

Over the next two decades (1840-1860), it became clear that the region was of great interest geo-politically. Its geographic location was central in access to the west as well as the United States, and seasonally as transportation by steamboats became common practice. Its natural resources began to draw the attention of not only the tourism industry, driven by American outdoor recreational activities, but fishers and loggers as well. By the end of 1862, a treaty between most of the Indigenous Peoples of Manitoulin Island and the Crown was ratified allowing non-Indigenous settlement on the island. This would mark the end of an era and the beginning of a new one, which saw a dramatic transition on the island. Manitoulin Island was logged largely in order to develop farming settlements; much of the western end became "unorganised" territory due to the karst rock formations. In the late 1870s, early 1880s, extensive logging led to the erection of sawmills with led to increased migration.

Death records can be used to gain insight into the connections between trends in cause-specific mortality and interacting population dynamics by providing contextual evidence to describe mortality risk factors and analyse observable death trends. The death records along with census and birth records reviewed in this study, begin in 1870 and as such reflect the changing population dynamics that would transpire over the next 50 years. These changes to population dynamics can manifest in the public health trends that follow. It is therefore important to take into account the landscape, the intersection of all the contextual environmental variables, during the analysis and interpretation of the data. Such considerations of the contextual environment on death trends reflect an eco-epidemiologic approach. The contextual environment represented in this study particularly by Defo's (2014) distal and macro contextual variables defined in the multi-level eco-epidemiologic life course framework.

In social epidemiological research, analyses of past trends in diseases, the epidemiologic transition model (Omran, 1971) is the main application. This model traces the transition between low life expectancy and a high likelihood of death due to infectious diseases, to high life expectancy and a high likelihood of death due degenerative, human-caused diseases.

Only considering the death trends (1870-1908 and 1921-1936), without contextual consideration of the environment, would likely suggest that this dataset represents the transition between Omran's (1977) 'age of receding pandemics' and 'age of degenerative, human-caused diseases.' These death trends reflect the pathology for the time period and the larger region. The causes of death largely reflect both infectious diseases, especially respiratory, and degenerative diseases such as heart, liver, and brain disease, and old age. Tuberculosis was the leading cause of death, and most of those who died were between the ages of 15 and 30. Other leading causes of death were lower respiratory tract infections and influenza.

It is difficult to infer the impact of degenerative, human-caused disease impacts as the relationship between risk factors and death are much more reflective of the contextual environment, or lifestyles lived, an impact which cannot be observed by death records and other population data alone. Consideration of the contextual environment reveals the extensive, largely untraceable in-and-out migration that occurred on the island between late 19th and early 20th century and the rest of Canada as a whole, impacting data registrations. This not only causes difficulties in misleading results, but also in fully understanding the impact of certain contextual environments in disease causation for this location and true representation of cause of death trends and rates.

The impacts of migration to Manitoulin Island are reflected by the three societal cohorts. The Indigenous People, settlers and immigrants experienced different social intersections and were impacted differentially by contextual environments; in particular an intersection between Defo's (2014) distal and macro-contextual variables, *institutional environment and capacity of the collectivity* (IECC) and *cultural, social, and economic environments* (CSEE). For Indigenous People, incomplete or absent mortality data prior to 1900 are likely due to under reporting which may be a result of Indigenous-governmental discourse and refusal by the former group to participate in any operations, especially those that required the collection of information or formal documents. Data collected in the Ontario 1871 and 1881 censuses have been deemed as fairly inadequate in their representation (McQuillan, 1985). This problem reflects an intersection between Defo's (2014) distal and macro-contextual variables HGPE, PCE, and *health systems and technology* (HST).

While none of the trends of deaths identified in this study are surprising, the existence of a much older migrant population and the underreporting in the documentation process may still skew the true representation of mortality in Manitoulin Island region. It is plausible to suggest that in terms of the epidemiologic transition, those born in the region of Manitoulin Island were generally not as likely to live as long as those who immigrated from more industrially advanced regions.

The research pathways and conclusions presented in this study provide a more detailed and causative, yet incomplete review of Manitoulin Island deaths at the turn of the century. This exploratory analysis reveals its usefulness in the exploration of cause-specific mortality and the intersection of infectious and non-communicable diseases. It has the potential to provide more details on the understanding of specific disease impacts, chiefly that of tuberculosis, diabetes and other contenders that embody cardiovascular complications (Waldram, Herring & Young, 2007).

Research in disease causation reveals a more rounded representation of the death trends visible in a dataset as it is more reflective of specific pathways that result in certain health trends and are not necessarily dependent on unknown or un-specific causes of death. More qualitative results regarding overall disease causation and health trends can be derived from this kind of analysis as the researcher reflects upon the type of vulnerability that represents the difference between morbidity and mortality. More thorough consideration of the contextual environment in social epidemiologic applications would generate more compatibility between applicable study comparisons. Ultimately, the responsibility for changing patterns in health and disease in the past, present and future lies in the intersections of contextually defined environments.

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