Rural Lifestyle, Chronic Illness and an Old Order Mennonite Community

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Background

The Ontario Mennonite community began in the late eighteenth century (from 1786 onward), when approximately two thousand Swiss Mennonites emigrated from Pennsylvania to Canada via the Niagara River (Macnaughton, 2002). While they initially lived and worked much like their non-Mennonite neighbours, the uniqueness of the Old Order started to develop in the mid-1800s. A major division occurred in 1889, with the majority forming a more liberal group that has since split into numerous other groups with churches in Kitchener-Waterloo and the surrounding area (Peters, 2003). The group that took the more conservative position in 1889 – officially called Old Orders – have also experienced several divisions that have resulted in smaller groups, including the Markham Group, the David Martins, the Elam Martin Group and the Orthodox Mennonites. This paper focuses on what is referred to as the

Old Order Mennonites, a group that today numbers almost 5,800 in Ontario.

While Ontario Old Order Mennonites live next to non-Mennonite neighbours, they separate themselves socially from the larger society. Their rural lifestyle is dictated by religious beliefs and agriculture is the preferred livelihood. Community and family goals transcend individual ones, simplicity is valued and change is gradual. Everyone receives schooling from a community-operated school house and no one has more than grade eight education. Travel is by horse and buggy (or bicycle or walking). Families are large (typically five to ten children) and Old Order Mennonite-based mutual aid replaces public health insurance (and covers up to 75% of all healthcare costs). Health behaviours include no smoking, low/no alcohol consumption, and high levels of physical activity (particularly among children and men). There is minimal reliance on technology and all government assistance programs are refused (Peters, 2003; Reimer, 2008). They use traditional and alternative healthcare when they think it is beneficial, though both Old Order Mennonites and mainstream society report that Old Order Mennonites often delay accessing medical care and seek it only when health concerns are serious (Dabrowska & Wismer, 2010).

Since few studies have examined the health of Old Order Mennonites, there is uncertainty as to how their unique lifestyle impacts their health. The broader social determinants of health (SDOH) literature suggests that there may be both benefits and risks associated with the Old Order Mennonite lifestyle, with benefits linked to the following features: behaviours such as no smoking, low/no alcohol consumption, and high levels of physical activity (Danaei, Vander Hoorn, Lopez, Murray, Ezzati, and the Comparative Risk Assessment collaborating group, 2005; Stringhini, Dugravot, Shipley, Goldberg, Zins et al., 2011); strong social capital, social support and social cohesion (Kim & Subramanian, 2008; Stansfeld, 2008); and high religiosity and spirituality (King & Koenig, 2009; Koenig & McCullough, 2001). The closed nature of the Old Order Mennonite community is a potential risk factor for genetic disease, due to negligible in-migration and increased likelihood of inbreeding (Puffenberger, 2003). The comparatively low incomes of Old Order Mennonites may be a potential health risk, since low socioeconomic status has been linked with poor health across many populations, diseases, and economic indicators (Adler & Ostrove, 1999). However, Old Order Mennonites are not typically considered of low socioeconomic status, since wealth is embedded in property and other agricultural assets. Underuse of healthcare services is another potential risk

factor, with studies of developed and developing countries showing that health insurance improves service use and access, and positively affects health and survival (Gu, Zhang, & Zeng, 2009).

Study Purpose and Contribution

The purpose of this paper is to explore chronic illness in the Old Order Mennonites by looking at the prevalence of specific chronic conditions and the determinants of chronic illness in the population generally, as measured by the number of chronic conditions. Demographic characteristics are examined to provide both the mortality rates relevant to chronic illness and contextual information contributing to a general understanding of health in the Old Order Mennonites. The current study is a continuation of a larger project exploring health in the Old Order Mennonites. Previously published research reported on the determinants of physical and mental health in this community (Fisher, Newbold, Eyles, & Elliott, 2013a; Fisher, Newbold, Eyles, & Elliott, 2013b). The results of this study provide a more complete picture of health in the Old Order Mennonites, as well as information relating to the prevalence and predictors of chronic illness in farming populations.

Literature Review of Health in Old Order Mennonite Community and Similar Cultures

The genetic background of the Ontario Old Order Mennonites is unique in comparison to the general population in that current residents are primarily descendants of a defined group of founders who immigrated to Ontario starting in the late-eighteenth century. A likely consequence of this history is a gene pool that is relatively defined by an excess of common ancestry (consanguineous) marriages. The broader literature on the deleterious effects of inbreeding provide some evidence of increased mortality in children and young adults, but have failed to provide estimates of the effects on mortality and longevity (Morton, Crow, & Muller, 1956; Schull & Neel, 1972). Genetic studies specific to the Old Order Mennonite Waterloo lineage have identified a number of physical health disorders, yet there is a surprisingly high genetic diversity and consequently these disorders are relatively rare among the population (Puffenberger, 2003). Qualitative research may provide supporting evidence in that a broad-based discouragement of close

marriages within Waterloo Old Order Mennonites has been observed (Fretz, 1989).

Studies examining the health-lifestyle linkage have found that Waterloo Old Order Mennonite and Old Order Amish children demonstrate higher physical fitness levels than non-Old Order Mennonite/Old Order Amish urban and rural children (Bassett, Tremblay, Esliger, Copeland, Barnes et al., 2007; Esliger, Tremblay, Copeland, Barnes, Huntington et al., 2010; Tremblay, Barnes, Copeland, & Esliger, 2005). Most other (non-genetic) health information comes from American studies of the Old Order Amish, and indicates differences largely in favour of Old Orders (Old Order Mennonite or Old Order Amish) for death rate and life expectancy (Hewner, 1998; Mitchell, Lee, Tolea, Sheilds, Ashktorab et al., 2012), women's mental and reproductive health (Miller, Berwood, Flaherty, Millemeier, Chase et al., 2007), hypertension and risk of cardiovascular disease (Fuchs, Levinson, Stoddard, Mullet, & Jones, 1990; Glick, Michel, Dorn, Horwitz, Rosenthal et al., 1998), certain cancers (Hamman, Barancik, & Lilienfeld, 1981; Troyer, 1988; Westman, Ferketich, Kauffman, MacEachern, Wilkins III et al., 2010) and Type 2 diabetes (Hsueh, Mitchell, Schneider, St Jean, Pollin et al., 2001). There has also been evidence of higher obesity levels in the Old Orders (Fuchs et al., 1990), particularly among women (Fisher et al., 2013b; Jorgenson, Bolling, Yoder et al., 1972).

Research published from the same dataset used in the current study found that physical health (measured by the physical component summary score of the SF-12 health survey)[1] was better in non-Old Order Mennonite farmers living in the same location as the Old Order Mennonites, and health in Old Order Mennonite women was lower compared to both Old Order Mennonite men and non-Old Order Mennonite women. Physical health in both Old Order Mennonites and non-Old Order Mennonite farmers was significantly shaped by coping skills, body mass index, childhood disease history and age. Factors such as social capital, sense-of-place and spirituality, though found to be much stronger in the Old Order Mennonites, did not shape physical health in Old Order Mennonites or non-Old Order Mennonite farmers (Fisher et al., 2013b).

Methods

Study Location

The setting is Waterloo region, which is located in south-central Ontario, Canada. As of 2008, approximately two-thirds (3,770) of the Old Order Mennonites in Ontario lived in Waterloo region, primarily in the Townships of Woolwich, Wellesley and Wilmot.

Data Sources

Since 1988, the Ontario Old Order Mennonite community has compiled and publicly sold directories listing the names, birth and death dates, and contact information for the members of all Ontario Old Order Mennonite families (both Waterloo and non-Waterloo Old Order Mennonites). The directories are published every five years and those for the years 1988 to 2008 were used to establish the age/gender population distribution and statistics pertaining to births, deaths, and migrations (Weber, 1993, 1988; Weber, E., Weber, L., Bearinger, W., & Bearinger, N., 2008; Weber, E., & Weber, L., 1998, 2003).

A specially designed, self-report survey was administered in 2010 to the Waterloo Old Order Mennonite and non-Old Order Mennonite farmers, with Old Order Mennonite study participants recruited through the churches. The senior Old Order Mennonite Bishop prepared a support letter to accompany the survey package, and arranged for the deacons to hand-deliver the survey packages to all adults after the spring 2010 church services. Anonymity was assured by providing Old Order Mennonites with a self-addressed, postage-paid envelope for mailing back the completed survey. Municipal tax rolls were used to identify non-Old Order Mennonite farmers. Directories of Mennonite and Amish groups were used to eliminate members of these groups from tax roll farmers, to avoid control group contamination. The survey obtained information on health status (including current and childhood chronic illness) and Canada's twelve determinants of health (Public Health Agency of Canada, 2015). Information in this survey was used for some of the results reported in this paper, including: total fertility rates, prevalence of chronic conditions and determinants of chronic illness.

This survey was used to obtain the prevalence of the following chronic conditions: allergies, farmer's lung, asthma, respiratory (emphysema, bronchitis, cardio-obstructive pulmonary disease), rheumatoid arthritis, osteoarthritis, back problems (not caused by

arthritis), high blood pressure, heart disease, effects caused by stroke, Crohn's disease, ulcerative colitis, irritable bowel syndrome, bowel incontinence, diabetes (not due to pregnancy), depression or dementia, cancer and other diseases. With the exception of farmer's lung, the conditions are the same ones used in Statistic Canada's Canadian Community Health Survey (CCHS) (Statistics Canada, 2015b). Participants were asked the following question about each condition: "Do you *currently* have any of the following conditions that have been diagnosed by a *health professional* (such as a family doctor or nurse practitioner)?" The response options were "Yes," "No," or "Don't Know."

The 2010 survey also asked participants whether they had a range of childhood disorders (for use in exploring the determinants of adult health) which included: measles/mumps/chicken pox, asthma and other respiratory illnesses, allergies, speech impediments, heart trouble, ear (chronic), headache or migraine, stomach problems, depression, childhood diabetes, hypertension, epilepsy/seizures, and 'other.' This list of disorders came from a childhood disease history study which developed the list in consultation with clinicians and epidemiologists knowledgeable about childhood diseases important for later life onset of disease (Smith, 2009).

Fertility, Migration and Mortality

The total fertility rate (TFR), defined as the average number of children born to a woman over her lifetime, was calculated for the Waterloo Old Order Mennonites and non-Old Order Mennonite farmers using data from the 2010 survey. The numerator of the calculation was the total number of children reported by women age fifty years or older, and the denominator was the number of women age fifty years or older that were married or widowed. Typically, women aged fifteen to forty-five are considered to be of child-bearing age, while in Old Order Mennonites and similar communities women rarely have children before age twenty and continue to have them as long as they can. Accordingly, the assumption for the purposes of calculating the fertility rate was a child-bearing age range of twenty to forty-nine (Hewner, 1998).

Migration was determined by comparing the addresses of each Old Order Mennonite family in two consecutive directories (i.e., 1988 and 1993, 1993 and 1998, 1998 and 2003, 2003 and 2008), with different addresses indicating that a migration had occurred. Since the directories were published every five years, the mid-point in the five year period was selected as the year of migration for all

migrations that occurred. Out-migrations to locations outside of Waterloo Region were common throughout the twenty-year period (1988 to 2008), whereas in-migration was negligible. The absence of evidence of in-migration in the directories was confirmed with the senior bishop of the Waterloo Old Order Mennonites community.

A variety of mortality rates were explored: the crude mortality rate (CMR), age-standardized mortality rate (ASMR), standardized mortality ratio (SMR), and specific (age, type) mortality rates. The ASMR and SMR are the direct and indirect methods (respectively) of adjusting the CMR for the different demographic structures of populations being compared. While both methods are valid and frequently used in public health studies, the ASMR is the more common measure particularly when more than two populations are involved in the comparison (Boston University, School of Public Health, 2015). Specific mortality rates pertain to specific segments of the population; this study explored two segment rates: age-specific mortality rates for five-year age groupings, and cause-specific mortality rates for major chronic condition groups (e.g., cancer, cardiovascular disease, respiratory illness) (University of Ottawa, 2015). Hewner (1998) provides a worked example of how to calculate the CMR and ASMR for the Amish population; these methods were employed in this study, using the 1991 Canadian population as the standard population. Methods used for significance testing were the normal approximation method for the ASMR (Mo, Li, & Zimmerman, 2008) and Poisson confidence intervals for the SMR (Buchan, 2004).

Chronic Illness (Prevalence, Determinants)

Age-adjusted standardization is also frequently employed to adjust for age differences in populations for comparing prevalence rates of chronic conditions. As this method proved difficult to implement due to the small number of chronic conditions reported by the two groups, we therefore adjusted for age differences by restricting the Old Order Mennonite sample to participants that met or exceeded the minimum age of the *non-Old Order Mennonite* sample (twenty-eight years old). Prevalence rates were calculated for the two groups and appropriate significance tests (chi-square, Yates adjusted and Fisher's exact test for small cell sizes) were applied to explore the differences between Old Order Mennonites and non-Old Order Mennonites.

The determinants of chronic illness were explored using multiple regression. The datasets for the Old Order Mennonites and

non-Old Order Mennonite farmers were combined in an analysis to explore the predictors of the number of chronic conditions. The independent variables included a range of factors measuring the social determinants of health, including: age, gender, marital status, income, stress, coping, control, social support, social interaction, number of childhood disorders, reciprocity given/received, sense of place, trust and spirituality. These same variables were used in a previous analysis of the determinants of physical health (measured using the physical component score from the SF-12 health survey); the manuscript summarizing these results provides information on how the variables were defined and measured (Fisher et al., 2013b). In the current study, these variables and a variable indicating group membership (Old Order Mennonites versus non-Old Order Mennonites) comprised the list of independent variables, with this latter variable intended to represent the other potential factors differentiating the two groups. Negative binomial regression was used to identify the factors predicting the number of chronic conditions; this type of regression (or Poisson regression) is more appropriate than ordinary regression when the dependent variable is a count-based measure (Afifi, Kotlerman, & Cowan, 2007).

Statistical analyses were conducted using SAS version 9.2. A significance level of $p=0.05$ was employed in all calculations.

Results

Survey Sample Characteristics

Table 1 compares the Old Order Mennonite and non-Old Order Mennonite samples from the 2010 survey. This table is a brief comparison of the groups, with a comprehensive comparison of the sample characteristics found in previously published research from this project (Fisher et al., 2013b). The Old Order Mennonite sample was 1,171, representing 60% of the Waterloo adult (eighteen years of age or older) Old Order Mennonite population. The non-Old Order Mennonite sample was 344, representing an estimated 30-40% of the non-Old Order Mennonite farming population. The Old Order Mennonite sample was younger, with a mean age of 43.4 years, compared to 57.8 years for the non-Old Order Mennonites. The Old Order Mennonite sample contained proportionately more women (58%), compared to a gender-balanced sample for the non-Old Order Mennonites. The Old Order Mennonite sample con-

tained proportionately more singles (33%), whereas singles represented only 5% of the non-Old Order Mennonite sample.

	Old Order Mennonites	**Non-Old Order Mennonites**
Sample Size	1171	344
Response Rate	60%	30-40% (estimate)
Mean age	43.40	57.76
% Females | % Males	58 | 42	51 | 49
% Married | % Single	64 | 33	87 | 5

Table 1: 2010 Survey Sample Characteristics – Waterloo Old Order Mennonites and Non-Mennonite Farmers

Demographic Characteristics

1. Population Pyramids

Population pyramids for the Ontario Old Order Mennonite population (Figure 1a) compared to the Ontario general population (Figure 1b, next page) based on the 2008 Old Order Mennonite directory (Weber, E. et al., 2008) and 2006 census (Statistics Canada, 2006a), show the percentages of the total population by sex and age cohort.

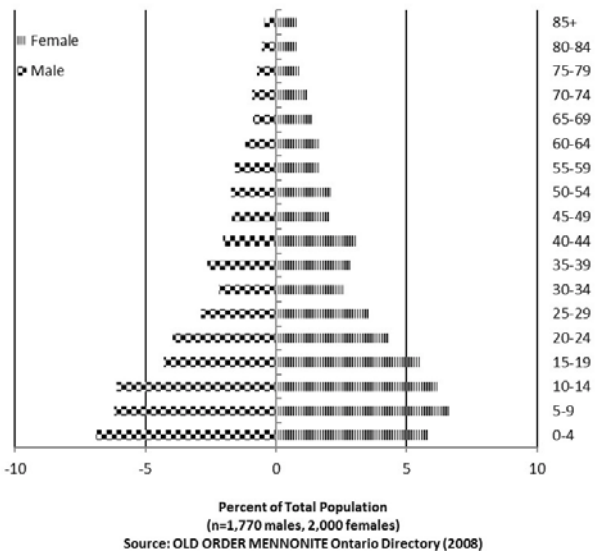

Figure 1a. Percentage of Old Order Mennonite Population by Age and Sex (2008)

The Old Order Mennonite pyramid demonstrates a comparatively young population with a large percentage of children and a small percentage of older adults, whereas the Ontario pyramid shows an aging population with a large number of older adults, consistent with broader demographic trends in Ontario. The median age and proportion of the population over age sixty-five also capture key age differences in the two populations: the median age of the Ontario Old Order Mennonite population in 2008 was 19.7 years compared to Ontario's 39 years in 2006, and the proportion 65 years and older was 6.7 % for Ontario Old Order Mennonites versus 13.6 % for Ontario (Ontario Ministry of Finance, 2007).

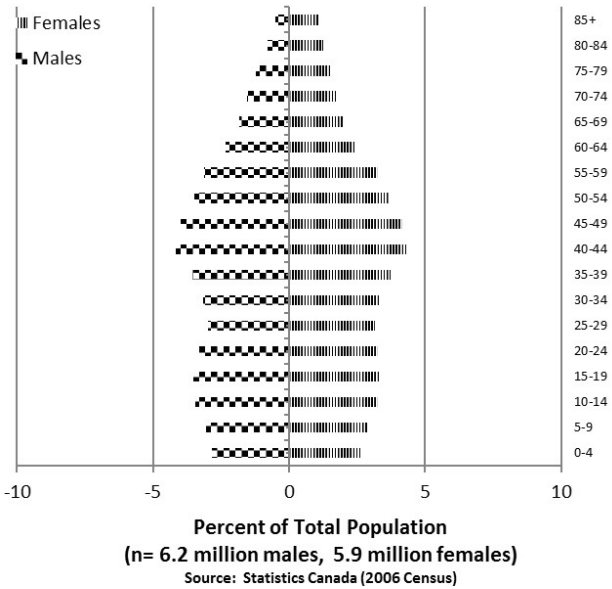

Figure 1b. Percentage of Ontario Population by Age and Sex (2006)

Over the twenty-year period 1988 to 2008, the *Waterloo* Old Order Mennonite population pyramid has remained relatively stable. Less stability exists in other (non-Waterloo) Ontario regions during this period, which have become home to many Old Order Mennonites who have left Waterloo in search of affordable farmland. For example, more than a dozen families have recently moved to Matheson (northeast Ontario) and have established an Old Order Mennonite community, including a church. Moreover, church leaders have also investigated the potential for establishing communities in other provinces, notably Prince Edward Island and

Saskatchewan. This migration, in addition to fertility and mortality, impact the Old Order Mennonite population structure. The next sections examine each of these factors in an effort to better understand their relative impact on population demography, health and chronic illness.

2. Fertility

The crude birth rate, or number of births per 1,000 people, was estimated from the Old Order Mennonite 1988-2008 directories and compared to Ontario's rate over the same period (Statistics Canada, 2006b). As Figure 2 shows, the Old Order Mennonite rate was, as expected, above the Ontario rate over the entire period, with the Old Order Mennonites' rate double Ontario's in 1993 and triple Ontario's in 2003. Data from the 2010 survey also allowed us to compare the fertility of Waterloo Old Order Mennonites to non-Old Order Mennonite farmers. These data show that the fertility of Waterloo Old Order Mennonites is also above that of non-Old Order Mennonite farmers. For example, the TFR was 6.1 for Old Order Mennonite women compared to 3.0 for non-Old Order Mennonite women. Although the range of number of children born to women in both groups was the same (0-9), only one-third of Old Order Mennonite women had three or fewer children, compared to two-thirds of non-Old Order Mennonite women. Another one-third of Old Order Mennonite women had eight or more children, compared to only 1% of non-Old Order Mennonite women.

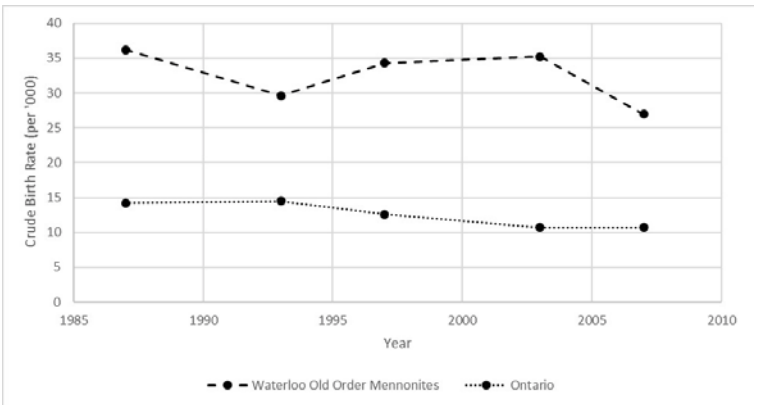

Figure 2. Crude Birth Rate (per '000) for Waterloo Old Order Mennonites and Ontario (1988-2008)

3. Migration

Migration is somewhat endemic to the Mennonite culture, due to a past characterized by the continuous need to separate from the larger society in order to achieve religious liberty, avoid persecution, and exercise agricultural skills (Macnaughton, 2002). Over the past twenty years, migration into the Waterloo Old Order Mennonite community has been negligible, whereas migration out of the community has been substantial due to individuals either leaving the Old Order culture and/or having to move outside Waterloo in order to purchase affordable farmland. The impact of out-migration on the Waterloo Old Order Mennonite community can be seen in the population characteristics shown in Table 2. The Waterloo Old Order Mennonite community increased from 3,066 to 3,770 people over the twenty-year period under investigation, with a growth rate of 13% in the first decade and 9% in the second. Out-migrants during the first decade totaled 440 individuals, of which 211 left the Ontario Old Order Mennonites and 229 remained Old Orders but moved away from Waterloo. During the second decade, there were 503 out-migrants, of which 166 left the Ontario Old Order Mennonites and 337 remained Old Orders but moved away from Waterloo. In contrast to the Waterloo Old Order Mennonite community, non-Waterloo Old Order Mennonite communities grew significantly over the twenty years, doubling in number from 533 to 1,062 in the first ten years and growing another 78% over the next ten years (increasing from 1,062 to 1,897 individuals). Out-migrants from the Waterloo Old Order Mennonite community, combined with high fertility rates, account for the high growth rates observed in the non-Waterloo Old Order Mennonite communities.

The proportion of older adults (age sixty-five years and older) in the Waterloo Old Order Mennonite community was between 8% and 9% from 1988 to 2008, and much lower (1 to 3%) for the Old Order communities outside of Waterloo (Table 2). This difference reflects the migration of younger Old Order Mennonites to locations outside of Waterloo. Overall, these rates are lower than the proportion of older adults in Ontario, which increased progressively from 10.7% in 1988 to 13.5% in 2008 (Statistics Canada, 2015a). The lower proportion of older adults in the Old Order Mennonite communities compared to Ontario do not reflect higher mortality rates (see below), but rather higher fertility rates, as observed in similar studies on the Old Order Amish (Hewner, 1998). Indeed, while the Waterloo Old Order Mennonite older adult population grew from 259 to 332 individuals over these twenty years, the pro-

portion of older adults in the population remained stable over the period.

	Waterloo Old Order Mennonites (OOMs)[2]			Non-Waterloo Old Order Mennonites[2]		
	1988	**1998**	**2008**	**1988**	**1998**	**2008**
No. of Males	1,447	1,628	1,770	273	552	997
No. of Females	1,619	1,831	2,000	260	510	900
Total Population	3,066	3,459	3,770	533	1,062	1,897
Female (%)	53	53	53	49	48	47
Population Growth Rate (10 yr)	-	13	9	-	99	78
Median Age (Years)	20	21	21	13	14	17
Population Age 1-19 Yrs (%)	49	46	48	55	59	55
Population Age 65+ Yrs (%)	8	9	9	1	3	2
Ontario OOMs (%)	85	77	67	15	23	33

Table 2: Population Trends from 1988-2008 - Ontario Old Order Mennonites

4. Mortality

Table 3 (next page) provides the CMR, ASMR and SMR for the Ontario Old Order Mennonites compared to the Ontario general population. The CMR for Old Order Mennonites was lower (4.6) than the rate for the Ontario population (7.1) by 35%. However, the Old Order community is much younger and has many children, so we should expect to see a lower CMR for that population. The direct method of standardization (ASMR) narrows the gap and results in a rate difference still in favour of the Old Order Mennonites and 13% lower than Ontario's rate, a difference that is statistically significant ($z=5.85$, $p \leq 0.001$). The indirect method of standardization (SMR) results in a rate of 0.91 for the Old Order Mennonite population. Although the range of the 95% confidence interval for the SMR is primarily below 1.0, the upper limit is slightly above it (1.01), suggesting that there may be no difference in the mortality rates between Old Order Mennonites and the Ontario general population.

Mortality Measure	**Value**
Crude Mortality Rate (CMR) (Old Order Mennonites), 1988-2008 *(per '000)*	4.6-35 (Old Order Mennonites lower)
Crude Mortality Rate (Ont.), 1998 (Midpt. of 1988-2008) *(per '000)*	7.1
Diff. in Crude Mortality Rate – Old Order Mennonites vs. Ontario (%)	-35 (Old Order Mennonites lower)
Age-Standardized Mortality Rate (ASMR) (Old Order Mennonites), 1998-2008 *(per '000)* (Standardized to 1991 Canadian Population)	5.5
Age-Standardized Mortality Rate (Ontario), 1988-2008 *(per '000)* (Standardized to 1991 Canadian Population)	6.3
Diff. in Age Standardized Mortality Rate – Old Order Mennonites vs. Ontario (%)	-13 (Old Order Mennonites lower)
Test of significance of ASMRs (Normal Approx. Method)	Z = 5.85 ($p<0.001$)
Standardized Mortality Ratio	0.91
95% Confidence Limits for Standardized Mortality Ratio	0.81-1.01

Table 3: Crude Mortality Rate (CMR), Age-Standardized Mortality Rate (ASMR), and Standardized Mortality Ratio (SMR) for Waterloo Old Order Mennonites (1988-2008)

We calculated age-specific and cause-specific mortality rates for Old Order Mennonites and the Ontario general population. Figure 3 shows the ratio of the age-specific rates for the two populations, with '1' representing the point where the rates are equal. The general pattern shows higher rates in Old Order Mennonites for the youngest age cohorts, lower rates in Old Order Mennonites for the adult age groups, and similar rates in both populations in the oldest age groups. Cardiovascular disease and cancer accounted for 66% of all deaths in Old Order Mennonites over the period 1971 to 2008, which is similar to Ontario's proportion (63%) over the same period (Statistics Canada, 2009, 2011). Similar trends over time were seen in both populations, with a decline in the proportion of deaths due to cardiovascular disease and a rise in the proportion of deaths due to cancer. Table 4 (next

page) compares the mortality rates for the main chronic conditions in the two populations.

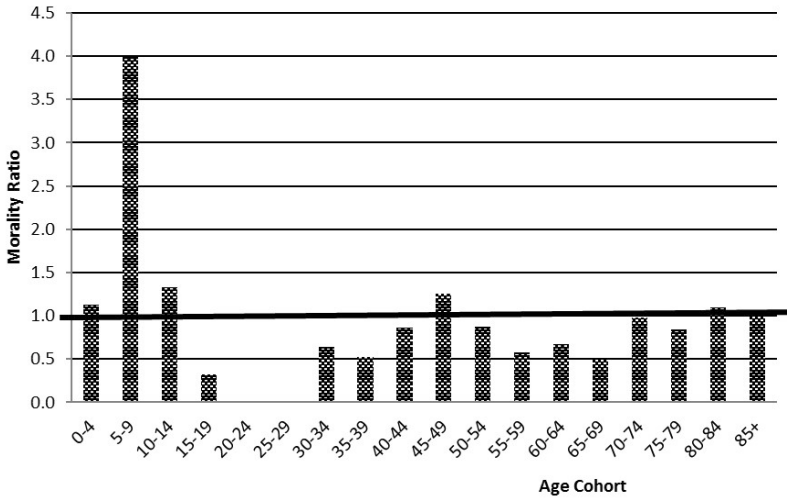

Figure 3: Waterloo Old Order Mennonites vs. Ontario Mortality Ratios (1988-2008)
(Ratio = Waterloo Old Order Mennonite Age-Specific Mortality Rate/Ontario Age-Specific Mortality Rate)

For cancer, the Old Order Mennonite mortality rate was lower than the Ontario rate (0.999 versus 2.037) and the 95% confidence intervals did not overlap (0.63-1.37 versus 1.51-2.56), suggesting lower cancer rates in the Old Order Mennonites (Table 4, next page). For cardiovascular disease (heart and stroke conditions), the Old Order Mennonite mortality was lower than the Ontario rate (2.039-2.510), but the 95% confidence intervals overlapped (1.51-2.57 versus 1.92-3.10) suggesting no difference in the rates for the two populations. When we combined cancer and cardiovascular disease together (since both conditions share many of the same risk factors), lower mortality rates were observed in Old Order Mennonites (3.038 versus 4.547) and there was no overlap in the confidence intervals (2.39-3.68 versus 3.76-5.34), suggesting that the Old Order Mennonite mortality rate for the combined conditions was lower than the Ontario rate. No significant differences in respiratory or other conditions were observed between the two populations.

	Waterloo Old Order Mennonites (1988-2008)			Ontario (2000)		
Cause of Death	**No. of Deaths**	**Crude Mortality Rate** *(per '000)*	**95% CL**	**No. of Deaths**	**Crude Mortality Rate** *(per '000)*	**95% CL**
Cancer	73	0.999	0.63–1.37	23,805	2.037	1.51–2.56
Cardio-vascular *(Heart & Stroke)*	149	2.039	1.51–2.57	29,330	2.510	1.92–3.10
Cancer and Cardio-vascular	222	3.038	2.39–3.68	53,135	4.547	3.76–5.34
Respiratory	28	0.383	0.15-0.61	6,300	0.539	0.27-0.81
Other	89	1.22	0.81–1.63	21,855	1.871	1.36–2.38

Table 4: Cause-Specific Mortality Rates (Waterloo Old Order Mennonites vs. Ontario General Population)

Chronic Illness

The 2010 survey results enabled us to compare the (self-reported) prevalence of chronic illness in the Waterloo Old Order Mennonites compared to the non-Old Order Mennonite farmers. The reported prevalence of almost all of the conditions was lower in Old Order Mennonites, and the differences were statistically significant (Table 5). The only condition with a lower prevalence in non-Old Order Mennonites was depression, although the difference was not statistically significant. These prevalence rates represent crude rates that are influenced by differences in the population distributions of the two groups. Since the Old Order Mennonite sample was significantly younger than the non-Old Order Mennonite farmers (Table 1), we should expect the rates of chronic illness to be lower. When we restricted the Old Order Mennonites sample to those age twenty-eight and over (minimum age of non-Old Order Mennonites), most of the differences were no longer significant, with only the following remaining lower in Old Order Mennonites versus non-Old Order Mennonites: allergies (8% versus 18%, $p<0.001$), arthritis (9% versus 19%, $p<0.001$) and all colon/bowel disorders (4.5% versus 8%, $p=0.01$). Respiratory conditions (6% versus 9%, $p=0.05$) and back problems (19.5% versus 25%), $p=0.05$) were both marginally significant. Interestingly, allergies

and respiratory conditions were also among the few childhood conditions where a significant difference was observed between the groups, with Old Order Mennonites reporting lower rates (both $p<0.001$); the other two childhood conditions were ear problems and measles/mumps/rubella (neither were included on the chronic conditions in adults).

Condition	Old Order Mennonites (n=1,171)		Non–Old Order Mennonites (n=344)		Significance Test	
	N (with)	% (with)	N (with)	% (with)	X^3	P - value
1. Allergies	98	8	63	18	27.8	<0.001
2. Farmers Lung[3]	15	1	4	1	0.01	>0.50
3. Asthma	38	3	18	5	2.95	0.086
4. Respiratory[3]	7	1	9	3	7.75	0.005
All Respiratory (2-4)	*60*	*5*	*31*	*9*	*7.10*	*0.008*
5. Rheumatoid Arthritis	34	3	22	6	9.10	0.003
6. Osteoarthritis	47	4	45	13	38.3	<0.001
All Arthritis (5,6)	*81*	*7*	*67*	*19*	*47.58*	*<0.001*
7. Back	208	18	85	25	8.23	0.004
8. Blood Pressure	151	13	65	19	7.83	0.005
9. Heart	46	4	20	6	2.27	0.13
10. Stroke[3]	8	1	2	1	0.03	0.86
All CVD[4] (8-10)	*205*	*17.5*	*87*	*25*	*10.36*	*0.001*
11. Crohns[3]	4	0.3	3	1	0.68	0.41
12. Colitis[3]	4	0.3	3	1	0.68	0.41
13. IBS	16	1	16	5	13.88	<0.001
14. Bowel	20	2	6	2	0.002	0.96
All Colon/Bowel (11-14)	*44*	*4*	*28*	*8*	*11.28*	*<0.001*
15. Diabetes	33	3	19	6	5.87	0.02
16. Depression	69	6	16	5	0.77	0.38
17. Cancer	17	1	12	3	5.87	0.02
18. Other	107	9	52	15	10.12	0.002

Table 5: Prevalence of Chronic Conditions in Waterloo Old Order Mennonites compared to Waterloo Farmers

Finally, we explored chronic illness in Old Order Mennonites and non-Old Order Mennonites by examining the determinants of

the number of chronic conditions, using negative binomial regression. Table 6 provides the independent variables that were significant in the regression model, with the value of the variable associated with an increase in the number of chronic conditions shown in brackets. The variables that were significant predictors of the number of chronic conditions were: inadequate income, poor coping skills, high stress levels, more childhood conditions, higher BMI, and older ages. The group variable was also significant in the model and indicates that being an Old Order Mennonite is associated with a higher number of chronic conditions. The presence of the group variable indicates that there are characteristics of the Old Order Mennonite population, other than those included in the model, that are linked with a higher number of chronic conditions. This can be seen in some of the descriptive statistics for the two groups. For example, the mean number of chronic conditions in the Old Order Mennonite sample was 1.37 compared to 1.34 in non-Old Order Mennonites, and the variability was higher in Old Order Mennonites (standard deviation of 2.02 versus 1.53). The range was also higher, with 0-14 conditions reported by Old Order Mennonites compared to 0-10 conditions for non-Old Order Mennonites.

Independent Variable	**Estimate (Std Error)**	**p- value (for Wald X^2)**
Group Old Order Mennonites	0.49 (0.10)	<0.0001
Income (Inadequate vs. Adequate)	0.37 (0.10)	<0.0001
Coping (Poor/Fair vs. Good/Excellent)	0.31 (0.10)	0.0019
Stress (High vs. Low)	0.42 (0.13)	0.0009
# Childhood Disorders (≥ 2 vs. <2)	0.54 (0.07)	<0.0001
BMI (≥30 vs. <30)	0.29 (0.08)	0.0004
Age (75+ vs. ≤ 45 years old)	1.18 (0.08)	<0.0001

Table 6: Significant Variables Predicting Number of Chronic Conditions (Results from Negative Binomial Regression)

Discussion

This study reported on the prevalence and determinants of chronic illness in the Old Order Mennonites of Waterloo Region, as

well as the demographic characteristics for contextual background on health and mortality in this population.

The results indicate that the structure of the Waterloo Old Order Mennonite population has remained relatively stable over the twenty year period from 1988 to 2008, similar to the observations of the Old Order Amish over the forty year period 1953 to 1993 (Hewner, 1998). The shape of the population pyramids for the Old Order Amish and Waterloo Old Order Mennonites are also similar, and both demonstrate a large percentage of children and small percentage of older adults. However, the underlying population growth rates differ, with the Waterloo Old Order Mennonite population increasing 23% over the twenty year period compared to a doubling of the Old Order Amish population over a similar period (twenty-three years) (Hewner, 1998). Hewner attributes the significant growth rate in the Old Order Amish to high fertility rates, referring to the Old Order Amish as a natural fertility population (defined as a population where there is little fertility control beyond natural methods). Similarly, the Waterloo Old Order Mennonites are a natural fertility population, supported by the finding in this study that fertility rates were two to three times that of the non-Old Order Mennonite farmers and Ontario general population. The Old Order Mennonites high fertility rate raises the question: what is the cause of the relatively slow population growth rates observed in Waterloo Old Order Mennonites?

The answer is not high mortality rates, as this study found that crude and age-adjusted mortality rates were, if anything, lower than those observed for the Ontario general population. The answer lies in an examination of migration, with this study identifying both negligible in-migration and substantial out-migration from the Waterloo region. Migration away from Waterloo in search of affordable farmland began in the mid-1980s and continues to this day, with some families relocating to other parts of Ontario, including Pembroke (600 kilometers from Waterloo), Lindsay (360 kilometers away), and Lucknow (190 kilometers away) (Peters, 2003). Growth rates in communities outside of Waterloo are similar to the rapid growth rates observed for start-up Old Order Amish communities; for example, the population in communities outside of Waterloo tripled in the period just after it was established (1988 to 2008) (533 to 1,897 – see Table 2), as did the Old Order amish community studied by Hewner in its first twenty years (1998). Interestingly, although out-migration has played a role in suppressing population growth rates and shaping the Waterloo Old Order Mennonite community, it has not changed

the population structure significantly, which Hewner also found for the Old Order Amish population she studied 1998).

It is less clear whether mortality rates are lower or the same in Ontario Old Order Mennonites compared to the province's general population, because the results differ for the two recommended approaches to adjusting for age differences between the two populations. According to the most frequently used method of adjusting for age differences (the direct method), the Old Order Mennonite mortality rate is 13% lower than Ontario's, a statistically significant difference. This is similar to the results for the Old Order Amish, where age-adjusted mortality rates (using the direct method) were found to be 19% below American mortality rates (statistical significance not explored) (Hewner, 1998). However, the upper confidence interval limit for the SMR includes 1.0, suggesting that there may be no difference between the Old Order Mennonite and Ontario rates.

For Waterloo Old Order Mennonites, the causes of death and proportions attributable to each cause are similar to that reported for the Ontario general population and the Old Order Amish, with cardiovascular conditions and cancer topping the list (Hamman et al., 1981; Hewner, 1998). There is some evidence from this study suggesting cause-specific mortality rates may be lower in Old Order Mennonites compared to the Ontario general population for cancer and the main chronic conditions causing death (cancer and cardiovascular combined). This is further supported by results from this study showing that age-specific mortality rates in the Old Order Mennonites are above Ontario's rates for mortality rates in children and young adults (consistent with the findings of genetic studies on inbreeding), but below Ontario's rates for the older age groups where the impact of chronic illness would be seen. However, current prevalence rates for these life-threatening conditions appear to be similar, at least compared to the Waterloo non-Old Order Mennonite farming population, suggesting that there may be no difference in the mortality rates for major causes of death such as cancer and cardiovascular disease. Overall, once adjusted for age differences, only a few chronic condition rates remained lower in Old Order Mennonites, and of these, few represented life-threatening conditions (allergies, colon/bowel disorders, respiratory conditions, back problems). Interestingly, lower childhood rates were reported for some of the conditions that were found to be lower in adulthood (allergies, respiratory conditions), suggesting there may be genetic and/or cultural differences in Old Order Mennonites that result in lower rates of certain chronic conditions throughout the life course.

The picture of health in Waterloo Old Order Mennonites from this study differs somewhat from the study that explored physical health as measured by the primary component summary score (PCS) of the SF-12 short form health survey (Fisher et al., 2013b). A key finding from this latter study was that Waterloo Old Order Mennonites had poorer physical health compared to non-Old Order Mennonite farmers, primarily due to poorer health in Old Order Mennonite women. While many SF-12 studies find lower PCS scores among women, Old Order Mennonite women's scores were below both Old Order Mennonite men's scores and non-Old Order Mennonite women's scores, suggesting Old Order Mennonites women may face unique risks that do not relate to psychosocial, diet or weight management factors (Fisher et al., 2013b). Perhaps the mechanism underlying the gender-health relation in the Old Order Mennonite PCS results is linked to reproductive health, and if so cannot be easily compared with the chronic illness results from the current study. In general, PCS is an overall measure of physical health, and as such will not directly translate into risks for specific chronic conditions, thereby complicating the comparison of the results from the current study with the PCS study. However, similarities between the two studies are revealed in a comparison of the predictors of the health outcomes. Notably, the studies were in agreement on the majority of predictors of the physical health outcome (number of chronic conditions in the current study, PCS score in the PCS study), which were: income adequacy, coping, childhood disease history, BMI and age. In both studies, social factors (e.g., social support, social interaction, sense-of-place) did not shape physical health, perhaps due to the rural/farming status of the two groups being compared. This is suggested in the results from an Australian study on rural populations, that found that social relations and community support had less impact on *mental* health in farmers than non-farmers, and the researchers thought this may reflect higher self-reliance among farmers (Stain, Kelly, Lewin, Higginbotham, Beard et al., 2008).

The significance of the group variable in the regression model for the current study suggests that Old Order Mennonites may have a higher number of chronic conditions or experience more variability in chronic illness, even though they appear to have a lower prevalence for specific chronic conditions. For example, the standard deviation and range of number of chronic conditions was higher in Old Order Mennonites compared to non-Old Order Mennonite farmers. This may reflect the susceptibility of Old Order Mennonites to specific genetic conditions, and/or reflect cultural determinants of chronic illness beyond those included as inde-

pendent variables in the regression model. Further research is required to better understand the underlying reason(s) for a higher number of chronic conditions among Old Order Mennonites.

Study Limitations

Several study limitations should be acknowledged. First, the chronic illness and determinants data on Old Order Mennonites and non-Old Order Mennonites farmers rely on self-report and interpretation and are cross-sectional only. Accordingly, response bias may be present, and causality and directionality of the associations reported in this study cannot be confirmed. Future research employing a longitudinal design should be considered, in order to support and inform claims relating to causality and directionality. Reliance on self-report data will be difficult to overcome in any study of the Old Order Mennonites, since traditional data sources rely on public health registration numbers (e.g., Ontario Health Insurance Plan number for Ontario residents) for identification and follow-up.

Second, gender differences could not be reliably explored due to the small prevalence numbers for most chronic conditions in one or both groups compared in this study. Gender differences were apparent from other studies using this dataset (Fisher et al., 2013b), suggesting that gender is an important lens to use in health studies involving the Old Order Mennonites. However, it is challenging to apply a gender lens in exploring chronic illness in Old Order Mennonites and non-Old Order Mennonites, given the small size of the adult populations and resulting low occurrence rates for many (often rare) chronic conditions (calling into question a further breakdown by gender).

Third, the small adult Old Order Mennonite population requires the use of methods that may reduce the reliability of certain analyses performed in this study. For example, mortality rates were calculated over a twenty-year period for the Old Order Mennonites, whereas annual rates are calculated and published for the (much larger) Ontario population. Random variation related to the small size of the population results in annual mortality estimates in the Old Order Mennonites that widely fluctuate. Yet, calculating mortality over a twenty-year period is challenging too, because this ignores changes/trends occurring within the period (e.g., due to cultural changes occurring in the population or system changes in the delivery of healthcare services to them). The method of adjusting for age differences between Old Order Mennonites and non-

Old Order Mennonites is another example of how the small size of the population required a deviation from standard methods. This study could not employ traditional age-standardization methods because so few people reported certain chronic conditions in one or both groups, therefore a modified method to adjust for age differences was employed (i.e., Old Order Mennonite sample limited to the minimum age of the non-Old Order Mennonite sample).

Conclusion

Waterloo Old Order Mennonites use traditional and alternative healthcare services when they think it is beneficial, although the evidence suggests that they underutilize these compared to the general population, potentially disadvantaging them and increasing the risk of poorer health. However, the results of the current study suggest that this may not profoundly affect their morbidity and mortality, since chronic condition prevalence rates and age-adjusted mortality rates are similar or below the rates of the local farming population and/or the Ontario general population. Similar results have been reported in studies of the Old Order Amish. Moreover, the predictors of chronic illness in the Waterloo Old Order Mennonites are similar to those of the non-Mennonite population, and include fundamental determinants of health such as age, BMI, childhood disease history, coping and income adequacy. This observation highlights the importance of broader health policy solutions and cross-sectoral strategies to address fundamental health determinants that impact Mennonite and non-Mennonite populations alike.

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Notes

[1] The SF-12 is a shortened version of the SF-36 (36 question) health survey. The SF-12 reproduces the eight-scale profile of the SF-36 using 12 of the original 36 questions. The SF-12, as with the SF-36, offers two summary health measures, known as the physical component summary score (PCS) and the mental component summary score (MCS). These summary scores are frequently used as quality of life measures in health research. Numerous investigators and health care delivery organizations have adopted the SF-12®, including the National Commission on Quality Assurance (NCQA), which chose the SF-12® for its Annual Member Health Care Survey, and also the Pacific Business Group on Health, which will be one of the first to use

it in monitoring outcomes. For more information on the SF-36 and related suite of short-form instruments see: http://www.sf-36.org/tools/sf12.shtml.

[2] 440 and 503 Old Order Mennonites left the Waterloo community in 1998 and 2000, respectively. 211 and 166 of those who moved away in 1998 and 2000 left the Old Order culture, and the remaining 229 and 337 moved away from Waterloo to live in Old Order communities in other parts of the province.

[3] Yates chi-square correction applied due to small cell sizes.

[4] CVD = Cardiovascular Disease.