From Divergence to Convergence: The Sex Differential in Life Expectancy in Canada, 1971–2000*

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Au cours du XX[e] siècle, la différence de l'espérance de vie entre les sexes dans les pays industrialisés a augmenté en faveur des femmes. On a remarqué récemment un renversement du modèle à long terme de cet écart dans certains pays. Au Canada, entre 1981 et 2000, cette différence a diminué d'environ deux ans. Une grande partie de ce phénomène s'explique par un taux de mortalité moins élevé chez les hommes que celui auquel on se serait attendu par rapport aux cardiopathies, aux cancers du poumon, aux accidents et à la violence (les suicides non compris). Le changement de la prévalence du tabagisme chez les hommes et chez les femmes est en forte corrélation avec la modification de la mortalité due aux maladies du cœur et au cancer en fonction des sexes. Les raisons qui expliquent la diminution de la mortalité chez les hommes par suite d'accidents et de violence sont cependant moins claires et exigent des recherches plus approfondies.

Over the 20th century sex differences in life expectancy in the industrialized countries have widened in favour of women. Recently, a reversal in the long-term pattern of this differential has been noted in some countries. In Canada, between 1981 and 2000, this differential narrowed by almost two years. Greater than expected improvements in male death rates with respect to heart disease, lung cancer, accidents and violence (excluding suicide) explain a large part of this phenomenon. Change in male and female smoking prevalence correlates strongly with change in sex differences in mortality from heart disease and cancer. The reasons underlying men's greater mortality improvements in regard to accidents and violence are less clear and need further investigation.

DURING THE TWENTIETH CENTURY, mortality in the Western world and in Japan declined to unprecedented levels (Coale, 2003; Preston, 1976; Tuljapurkar, Li and Boe, 2000; White, 2002; White and Preston, 1996;

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Wilmoth, 1998; Riley, 2001; Vallin and Meslé, 2005). In this generalized context of improved survival probabilities, female life expectancy has surpassed that of males by an increasing margin (Stolnitz, 1956; Madigan, 1957; Enterline, 1961; El-Badry, 1969; Preston, 1976; Retherford, 1975; Waldron, 1976; 1986; 1993; Lopez, 1983; Vallin, 1983; 1993; 2002; Nathanson, 1984; Smith, 1993; Rogers, Hummer and Nam, 2000; Riley, 2001; Salomon and Murray, 2002; Luy, 2003; Meslé, 2004). Currently, life expectancy at birth in the industrialized countries ranges in the upper 70s for men and above 80 years for women (van Hoorn and Broekman, 1999; Population Reference Bureau, 2005). During the last quarter of the century an unexpected reversal in the long-established pattern of this differential has been noted: the female advantage in the average length of life has been declining steadily, in some cases since the early 1970s and in others since the early 1980s (Trovato and Lalu, 1996a).

Figure 1 shows the long-term trend in Canadian life expectancy and the corresponding change in the female/male difference in this measure. Early in the 20th century the differential was only between 2 and 3 years.[1] After the 1920s, however, it rose gradually to about 4.5 years in the 1950s, and to about 7 years in 1971. By the early 1980s, it had reached a peak point, and has declined thereafter to its current level of about 5.3 years. The Canadian experience parallels that of most other industrialized countries. In Sweden, for example, the difference in life expectancy between the sexes surpassed the 3-year mark by the mid-1950s; it rose to approximately 5.5 years in the early 1970s, then declined to just under 5 years by 1999 (Trovato and Heyen, 2003). For the United States, the historical pattern of change in this differential is remarkably similar to that of Canada (Smith, 1993: 83). In this country, the peak point occurred between the late 1970s and the early 1980s, at 7.70 years. Since then, it dropped to approximately 5.4 years in 2000.[2]

Study Objectives and Hypotheses

This investigation expands on recently published works in this area of mortality analysis (e.g., Trovato and Lalu, 1996a; 1996b; 1998; Pampel, 2002; 2003a; 2003b; Waldron, 1993; Nathanson, 1995). Rather than examining an aggregate of countries, as customarily done in this literature, here we look at the specific case of Canada over roughly a 30-year interval, from

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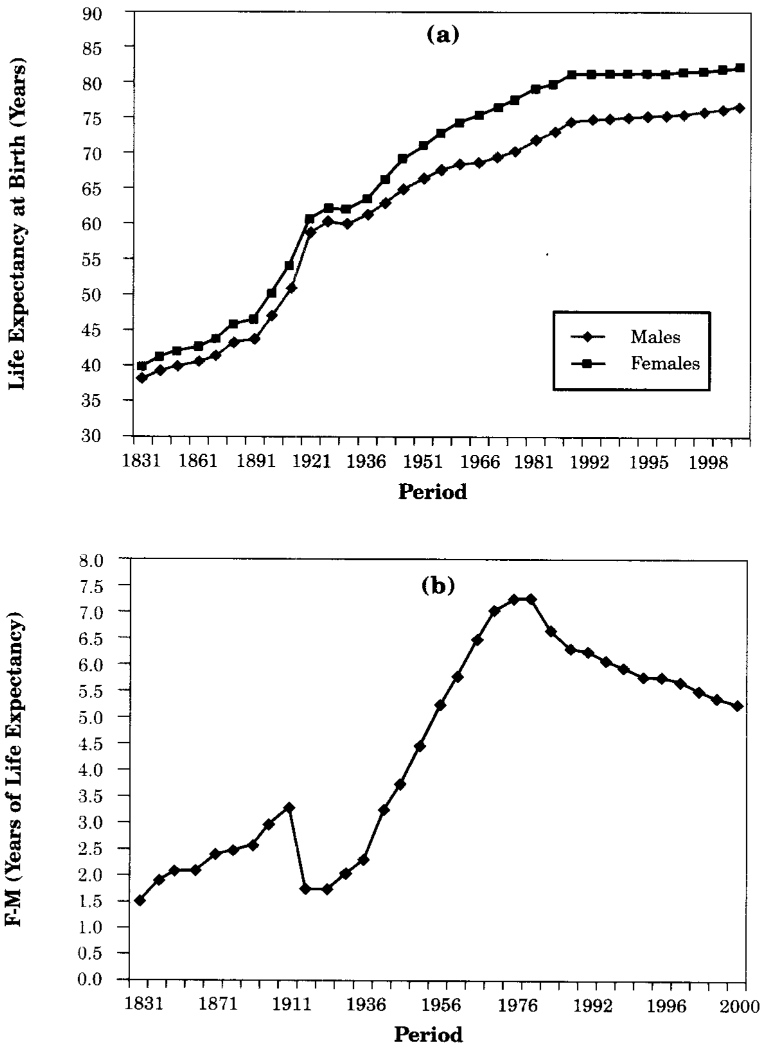
1. The sharp drop in the sex differential in life expectancy in Canada around 1921 seems unusual. It may reflect problems with the estimated historical life expectancy figures (e.g., the province of Quebec was not included in official statistics for Canada between 1921 and 1925), or possibly the consequence of some event or condition that may have caused a temporary decline in the sex gap in life expectancy. It is interesting to note that a similar situation has been documented for the United States, attributed to the greater female mortality during the influenza pandemic shortly before this time in history (Smith, 1993: 83; Noymer and Garenne, 2000). Perhaps the Canadian case is also reflective of this situation.
2. Lopez (1983) showed that, in England, Wales and Scotland, the peak in the sex gap in life expectancy had actually occurred by the early 1970s. Currently, among the most advanced countries, Japan remains an anomaly. Even though it has the highest life expectancy in the world, its sex differential in life expectancy has continued to increase in favour of women.

Figure 1

Historical Trend in Male and Female Life Expectancy at Birth (a) and the Female/Male Difference (b) in Canada



Sources: Peron and Strohmenger (1985: 115); Belanger (2003: 17); Nagnur (1986).

1971 to 2000.[3] Observed narrowing and widening of the difference in life expectancy between men and women must necessarily obtain from temporal shifts in sex differences in mortality from major causes of death. We examine, through statistical decomposition, the contribution of 10 causes of death to the change in the sex differential in life expectancy in Canada during this period. Conceptually, this analysis is situated in the context of the sociological literature concerning gender and the sex differential in mortality in industrialized countries. Specifically, we focus on the question of how change in the status of women pertains to changes in the sex differential in mortality and life expectancy, paying particular attention to the role of smoking.

A significant portion of the narrowing of sex difference in life expectancy in recent years is expected to be strongly linked to reductions in sex differences in death rates from chronic/degenerative diseases, particularly circulatory diseases and cancers, which account for a disproportionate number of deaths. In Canada, nearly two thirds of the 218,000 deaths in 2000 were due to these two categories of disease (World Health Organization, 2005).

Both cardiovascular and cancer mortality are strongly associated with long-term tobacco use (Doll and Peto, 1981; Peto, Lopez, Boreham, Thun and Heath, 2000; Ravenholt, 1990; Bartecchi, MacKenzie and Schrier, 1994; Waldron, 1976; 1986; 1995; 2000; Wister, 2005). In the United States, smoking caused approximately 435,000 deaths during 2000 (Mokdad, Marks, Stroup and Gerberding, 2004). Given the effect of smoking on health, we surmise that change in sex differences in smoking is related to change in the sex differential in life expectancy.

As in most industrialized countries, accidents in Canada claim a large number of lives annually (World Health Organization, 2005). Many such cases tend to be heavily concentrated in the young adult years, especially in men (Waldron, 1976; 1983; 1993; Perls and Frets, 1998; Owen, 2002). Alcohol is often implicated in many motor vehicle accidents. Although suicide and homicide rates have been declining recently, they remain an ongoing public health concern. In 2000, there were over 3,600 suicides and nearly 500 homicides in Canada (World Health Organization, 2005). We expect that change in sex differences in mortality from such causes would account for some of the observed narrowing of the sex differential in life expectancy in Canada in recent years.

Theoretical Framework

Societies in the Western world, including Japan, have passed through three stages of epidemiological transition: "the age of pestilence and famine"; "the age of receding pandemics"; "the age of man-made and degenerative

3. These recently published works do not extend the period of observation beyond the early or mid-1990s.

diseases" (Omran, 1971). As part of this process, populations experience widening sex differences in mortality, resulting from faster life expectancy gains among women, brought on by large-scale improvements in maternal mortality. As socio-economic modernization intensifies, men experience life changes that on the whole serve to slow their mortality improvements as compared to women. Part of this involves men's greater risks of death from accidents on the road and in the workplace, coupled with the adoption of unhealthy behaviours, most notably smoking and alcohol (Preston, 1976).

Recently, scholars have proposed additional stages of epidemiological transition. In 1986, Olshansky and Ault introduced "the age of delayed degenerative diseases" as a fourth stage, in which a large proportion of deaths annually result from chronic and degenerative ailments relatively late in life. In this stage, survival improvements in men and women tend to occur at more or less the same pace of intensity. Reflecting on these features, plus the fact that many deaths in high-income countries are due to modifiable risks associated with lifestyle and personal habits, Rogers and Hackenberg (1987) suggested we are now in a "hybristic" stage, characterized by a predominance of chronic/degenerative diseases related to aging coupled with a growing number of morbidities linked to unhealthy behaviours and lifestyles. Mokdad and colleagues (2004) show that in the United States, for example, the leading causes of death in 2000 were tobacco use (435,000 deaths), poor diet and physical inactivity (400,000), alcohol consumption (85,000), motor vehicle crashes (43,000), use of firearms (29,000), sexual behaviours (20,000) and illicit drug use (17,000). Taken together, these trends suggest that a large proportion of all deaths in Canada are due to preventable and modifiable lifestyle-related causes, of which lung cancer, heart disease, accidents and violence are important examples.

Smoking and the Sex Differential in Life Expectancy

Beside these epidemiological features of the industrialized countries, such societies are also in the midst of a "second demographic transition" (van de Kaa, 1987; 1999; 2004; Lesthaeghe and Surkyn, 1988), characterized by a pluralization of living arrangements among young adults, a pervasive tendency to postpone marriage, a large percentage of couples living in cohabiting unions, declining marriage rates, increased divorce probabilities, very high levels of contraceptive use, sub-replacement fertility rates, increased proportions of couples remaining childless, and an increasing tendency among couples for childbearing outside of traditional marriage. As part of this configuration of social change, gender roles in these societies have become increasingly egalitarian (Davis, 1984; McDonald, 2000).

Perhaps the observed convergence in life expectancy between men and women in recent years relates in part to the changing status of women in these societies. In addressing this question, we restrict ourselves to two strands of theorizing, based largely on the recent works of Pampel (2002; 2003a; 2003b) and Nathanson (1995), though clearly the studies of other researchers are also relevant (e.g., Waldron, 1976; 1986; 1991a; 1991b; 1993; Veevers and Gee, 1986; Verbrugge, 1976). Pampel's research emphasizes smoking diffusion as the mechanism for the reduction in death-rate differentials between men and women; Nathanson's explanation stresses change in the position of women as a central factor.[4]

An important indicator of the changing status of women is their degree of involvement in the paid labour force. In Canada, the participation rate for women aged 25 to 44 now stands at 80%; in the 1950s this was only about 20% (Roy, 2006). For the most part, this change has been beneficial for women, resulting in greater economic independence and increased well-being for their families (Sorensen and Verbrugge, 1987; Repetti, Matthews and Waldron, 1989). However, as part of this transformation, aspects of women's lifestyles may change; women may adopt some of the less positive features of the male gender role, thereby acquiring some of the mortality risks traditionally associated with men (Lopez, Caselli and Valkonen, 1995). To the extent that this is happening, women would at some point be expected to show some degree of erosion in their overall survival probabilities in relation to men (Nathanson, 1995).

One detrimental behaviour that has been increasingly adopted by women is cigarette smoking (Waldron, 1991a; 1991b; 1995; Lopez, Caselli and Valkonen, 1995; Pampel, 2002; 2001a; 2003a; 2003b; Rogers, Hummer, Krueger and Pampel, 2005; Patel, Back and Kris, 2005). The wide-scale adoption of cigarettes by women may reflect in part a rejection of traditional norms for appropriate female behaviour (Waldron, 1991b).

In Nathanson's (1995) conceptual model, change in the position of women in society (in terms of the division of labour, family status and political power) is viewed as a potential determinant of increased smoking prevalence. Nathanson (1995) hypothesized that countries with relatively high levels of gender equality would have a larger proportion of women smoking, which would in turn result in slower gains in female life expectancy at age 40. Nathanson's cross-national analysis revealed that in countries where the level of female smoking in 1970 was relatively high, women's life expectancy gains between 1970 and 1988 were slower than in those countries where smoking prevalence was low. For example, Japan, with very low female smoking rates, showed the largest increases in female life expectancy during this period. Denmark had the highest smoking prevalence for women, and it recorded the slowest gain in female life expectancy.

At the population level, the negative health effects of tobacco consumption are typically felt decades after the onset of widespread smoking adoption (Hegmann, Fraser, Kenny et al., 1993; Lopez, 1995; Nathanson,

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4. The causes of sex differences in mortality include a wide range of factors, from biological and genetic differences to structural and sociological causes underlying differential behaviours in men and women. For reviews of the literature see Luy (2003); Vallin (2002); Waldron (1976; 1995; 2000); Perls and Fretts (1998); Kramer (2000).

1995; Pampel, 2002). In a study of 22 high-income countries between 1975 and 1995, Pampel (2002) found support for the proposition that rising levels of female smoking over the course of the latter part of the 20th century, and the consequent lagged increases in female lung cancer and other smoking-related diseases in the 1970s and thereafter, fully accounts for the recently observed narrowing of the sex difference in mortality. In other words, it was concluded that all of the observed narrowing in the sex gap in mortality between 1975 and 1995 that was noted across industrialized countries has resulted from convergence in smoking prevalence between men and women: "The results . . . do not suggest that cigarette smoking fully accounts for the sex differential in mortality between males and females; rather, smoking fully explains the recent narrowing of the sex differential" (96). Thus, according to Pampel (2002), the female relative advantage in life expectancy has fallen because of women's adoption of smoking over the second half of the 20th century and its consequent lagged negative effects on their survival probabilities. This suggests that smoking-related mortality should account for much of the decline in Canada over recent decades in the sex differential in life expectancy.

Data and Methods

Mortality and population data were obtained from the World Health Organization electronic database (World Health Organization, 2005). Cause-specific death rates by age (0, 1–4, 5–9, . . . 85+), sex and period were computed, and used to generate appropriate abridged multiple-decrement life tables. International Classification of Diseases codes were grouped into 10 cause-of-death categories: 1) heart disease; 2) other diseases of the circulatory system; 3) lung cancer; 4) breast cancer; 5) prostate cancer; 6) all other cancers; 7) cirrhosis of the liver; 8) accidents and violence (excluding suicide); 9) suicide; and 10) all other causes of death (residual).

Observed differentials in life expectancy at birth between females and males were decomposed into the independent contributions of these ten cause-of-death components using a method adapted from one originally proposed by Das Gupta (1993), intended for the decomposition of rates (see Appendix A for a detailed description). The decomposition was executed in two steps. First, we decomposed the sex gap in life expectancy within a discrete period (i.e., 1971, 1981, 1991, and 2000, separately) to examine the contribution of each cause to the difference in life expectancy. Since male death rates from virtually all causes of death are greater than those of females, the contribution of most causes would be positive (i.e., to increase the female advantage in life expectancy). However, in some cases the contribution can be negative. One obvious example of this is breast cancer. Being predominantly a female problem, this type of mortality can only reduce the female advantage in life expectancy. On the other hand, prostate cancer, being strictly a disease that afflicts males, would always have a positive impact on the life expectancy differential (i.e., to increase the female survival advantage). A second part of the decomposition looked at the change over time in the contribution of given cause-of-death components to the change in the female-male difference in life expectancy. By this approach we were able to ascertain whether a specific category of mortality served to either widen or narrow the sex gap in life expectancy across any two discrete time periods.

Analysis

Table 1 includes decomposition of period-specific sex differences in life expectancy for 1971, 1981, 1991 and 2000 (i.e., columns 1 to 4). The decompositions are expressed in terms of years of life expectancy or fractions thereof. Columns 5, 6 and 7 in Table 1 reflect change in cause-of-death contributions between sequential periods. The sex difference in life expectancy shrank from just over seven years in the early 1970s to 5.347 years in the year 2000. Between 1981 and 1991, the sex gap narrowed by 0.77 of a year, and a further drop of 1.21 years was recorded between 1991 and 2000.

Within each of the four periods sex differences in heart disease mortality account for a large portion of the observed sex differentials in overall survival, though over time the magnitude of contribution by this component has been dropping, from 2.956 years in 1971 to 1.470 years in 2000. In substantive terms, this is indicative of appreciable reductions in sex difference in death rate from this particular disease. This effect has obtained from greater improvements in mortality in men as compared to women, especially since the early 1980s. It should be made clear, however, that both sexes have experienced gains in survival probabilities with regard to heart disease. That is to say, both men and women have seen declines in heart disease death rates, but the decline for men has been steeper than it has been for women. It is this differential in the pace of decline that explains why men have been able to close some of their relative disadvantage in life expectancy.

This point is reinforced by Figure 2, which shows the trend in age-standardized death rates for heart disease and all the other causes of death in this analysis. The faster downward trend in mortality for men in relation to women is evident for heart disease, as well as for virtually all other causes. The main exception to this is lung cancer, for which death rates continue to increase among women, while those for men stabilized in the 1980s and declined thereafter.

Beyond the large contribution of heart disease, sex differences in mortality from accidents and violence (excluding suicide) explain a substantial portion of the sex gaps in life expectancy in Table 1. This cause of premature mortality contributed between 1.42 years in 1970, and 0.62 years in 2000 of the difference in life expectancy. This drop in contribution over time indicates that Canadian men have managed to close some of their relative risk disadvantage in relation to women with respect to this cause of premature death. Figure 2 confirms this.

In regard to lung cancer, its pattern of contribution across periods also underlies substantial convergence in mortality rates between men and women. This is especially evident since the early 1990s (refer to columns 6 and 7 of Table 1 and also Figure 2). The timing of this effect relates to the variability in the stage of the male and female smoking epidemics. In the industrialized countries, including Canada, the epidemic for men started early in the 20th century, whereas for women it started much later, in the 1950s and 1960s. In recent decades smoking has become less popular, and many men have abandoned the habit. However, the prevalence of smoking among women has continued to increase (Lopez, Caselli and Valkonen, 1995; Waldron, 1995; Nathanson, 1995; Wister, 2005). It is therefore reasonable to assume that reductions in the sex difference in life expectancy since the early 1980s reflect shifts in past smoking behaviour by men and women (Pampel, 2001; 2002; 2003a). The pattern of change in the male lung cancer death rate in Figure 2 reflects widespread smoking cessation since the 1950s. Given a lag time of about 20 years, the stabilization and eventual drop in lung cancer mortality in men since the 1980s is linked to the cessation of smoking in the past. The female lung cancer epidemic has progressed unabated, largely as a function of increased rates of smoking during the postwar years (Pampel, 2002; Wister, 2005; Canadian Cancer Society, 2005).

Given its sex specificity, the contribution of breast cancer mortality to the life expectancy differential is consistently negative within each period in Table 1, whereas that of prostate cancer is consistently positive. As shown in columns 5, 6 and 7 of Table 1, breast cancer contributed to a narrowing of the difference in longevity between 1971 and 1991, but helped widen the difference in the interval between 1991 and 2000. This indicates that there have been recent declines in breast cancer mortality in women, and this has contributed to a small widening of the differential in life expectancy in their favour.

Concerning prostate cancer, during the last decade of the 20th century there have been some improvements in this cause of male mortality. Its effect over time has been to reduce the degree of life expectancy advantage in women. With respect to "other" cancers, sex differences in mortality have been diverging, thus helping to expand the sex gap in overall survival, but apparently at a diminishing pace (see columns 5–7 in Table 1). In other words, in comparison to women, men continue to experience higher mortality rates from "other" cancers, but over time the male excess mortality has been declining.

Although its contribution is relatively small, the effect of sex differences in cirrhosis of the liver death rates in the 1990s has been to narrow the sex difference in life expectancy. Some convergence in suicide risk has also occurred recently (see Figure 2). Its contribution has diminished since 1981, when it accounted for roughly 0.43 years of the observed sex gap in life expectation.

Table 1

Decomposition of the Female-Male Differential in Life Expectancy at Birth (e^0) by Period and Its Change Due to Ten Cause-of-Death Components; Canada, 1971 to 2000

	Period			
	(1) 1971	**(2) 1981**	**(3) 1991**	**(4) 2000**
Female life expectancy	76.649	79.244	80.999	82.216
Male life expectancy	69.479	71.915	74.438	76.869
Difference: Female/Male	**7.170**	**7.329**	**6.561**	**5.347**
Decomposition				
Heart disease	2.956	2.800	2.067	1.468
Other circulatory	.394	.403	.352	0.302
Lung cancer	.681	.885	.838	0.527
Breast cancer	-.493	-.535	-.596	-0.511
Prostate cancer	.228	.286	.394	0.364
Other cancers	.344	.591	.742	0.838
Cirrhosis of liver	.145	.188	.140	0.120
Accidents/violence (-suicide)	1.415	1.131	.770	0.615
Suicide	.272	.394	.432	0.364
Other causes	1.228	1.186	1.422	1.260
Total	**7.170**	**7.329**	**6.561**	**5.347**

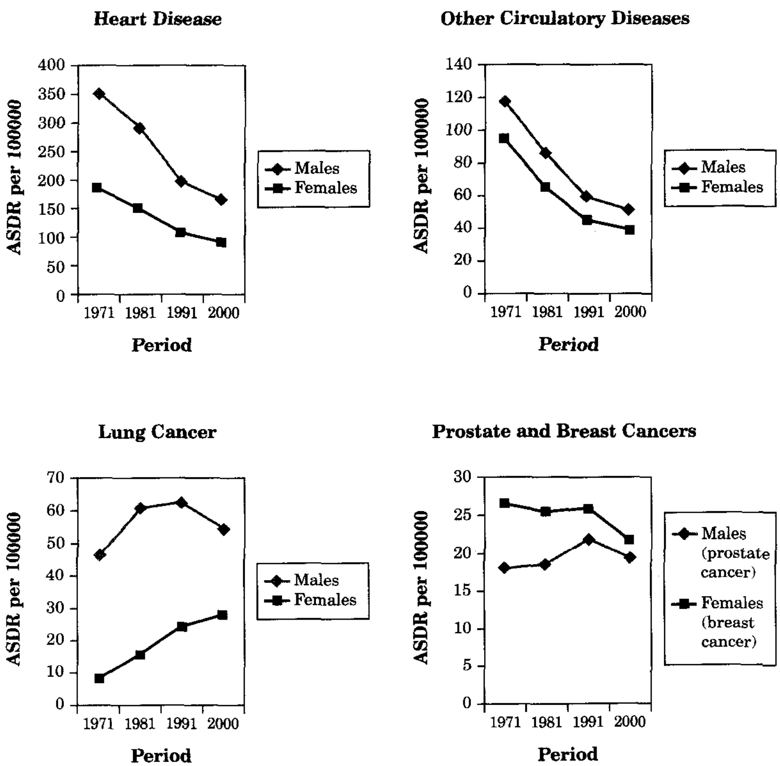
Note: The decompositions under columns (1) to (4) express the number of years of life expectancy or fraction thereof attributable to sex differences in a given cause of death.

Source: Authors' computations based on data from the World Health Organization (2005).

Change		
(5) 1971–1981	(6) 1981–1991	(7) 1991–2000
2.595	1.755	1.217
2.436	2.523	2.431
0.159	**-0.768**	**-1.214**
-0.156	-0.733	-0.599
0.009	-0.051	-0.050
0.204	-0.047	-0.311
-0.042	-0.061	0.085
0.058	0.108	-0.030
0.247	0.151	0.096
0.043	-0.048	-0.020
-0.284	-0.361	-0.155
0.122	0.038	-0.068
-0.042	0.236	-0.162
0.159	**-0.768**	**-1.214**

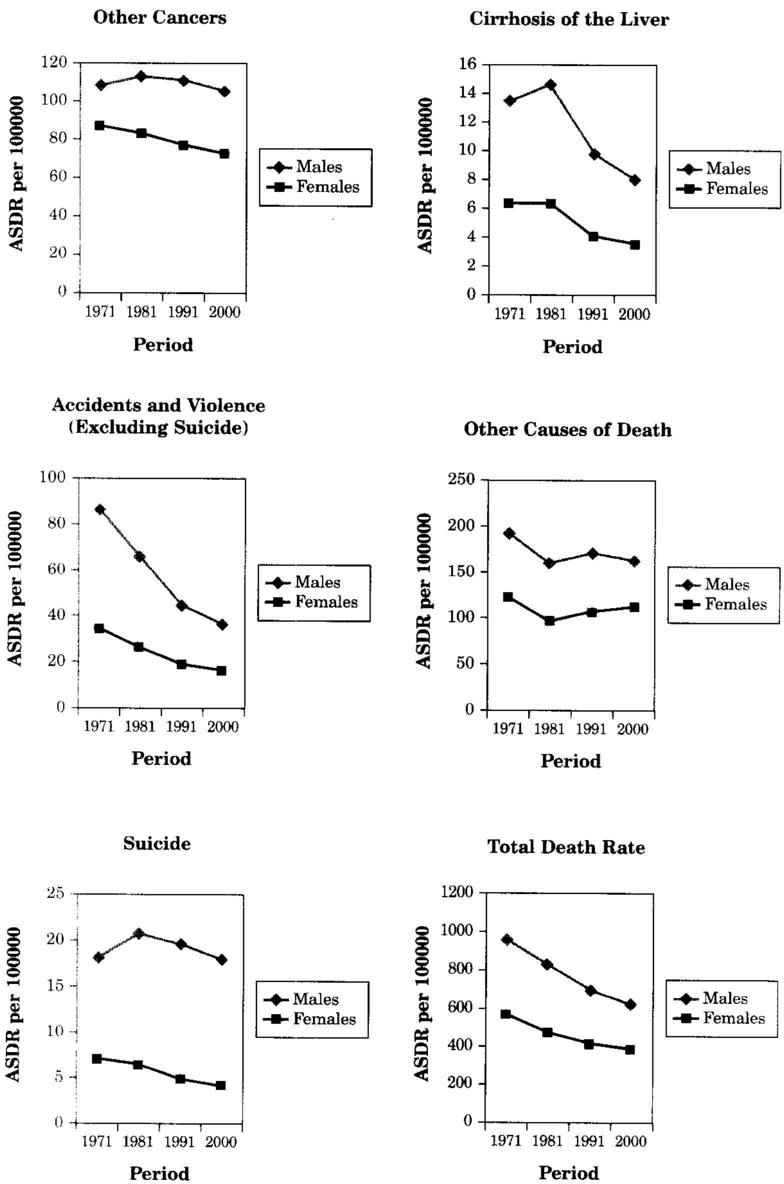
Figure 2

Age-Standardized Death Rates (per 100,000 Population) (ASDRs) in Canada by Sex, Cause-of-Death Component and Total Death Rate, 1971 to 2000



Note: The standard population is the European standard *million* (World Health Organization, 1998).

Figure 2 (cont.)



Decomposition of the Interval between 1981 and 2000

Between 1981 and 2000, the size of the sex differential in life expectancy narrowed by almost two years (i.e., 1.982 years). Table 2 shows that most of this decline is attributable to reductions in sex differences in heart disease death rates (i.e., by 1.332 years, or a 67% contribution) and, to a lesser degree, to reduced sex differences in mortality from accidents and violence (26%), lung cancer (18%), "other" circulatory conditions (5%), and cirrhosis of the liver (3%). The remaining cause-of-death components, namely breast cancer, prostate cancer, "other" cancers and the "residual" component, all show positive effects (i.e., to widen the gap in the average length of life in favour of women), but for the most part these effects have been relatively minor (perhaps with the exception of "other" cancers, whose impact is about 12%).

Table 2

Change in the Contribution of Cause-of-Death Components to the Change in the Sex Difference in Life Expectancy at Birth in Canada between 1981 and 2000

Cause of Death Component	Contribution to the Change in the Female/Male Difference in Life Expectancy	% Contribution
Heart disease	-1.332	-67.20
Other circulatory	-0.101	-5.10
Lung cancer	-0.358	-18.06
Breast cancer	0.024	1.21
Prostate cancer	0.078	3.94
Other cancers	0.247	12.46
Cirrhosis of liver	-0.066	-3.43
Accidents/violence (-suicide)	-0.516	-26.03
Suicide	-0.030	-1.51
Other causes	-0.074	-3.73
Total change	**-1.982**	**100.00**

Note: A negative value for a cause component denotes that the effect of change over time in sex differences in mortality due to that cause of death served to narrow the sex gap in life expectancy; a positive sign implies the opposite effect.

Source: Authors' computations based on data from the World Health Organization (2005).

Contribution of Smoking-Related Mortality

From these results we can conclude that change in sex differences in lung cancer and other types of mortality associated with smoking (i.e., heart disease, other circulatory conditions, other forms of cancer) are key factors underlying observed shifts in the size of the sex gap in longevity in Canada. To further explore the association of past smoking trends for men and women with change in the sex differential in all-cause mortality, Figure 3 is included. It displays the lagged relationship between sex differences in smoking at t-20 years ago (i.e., the ratio of female to male smoking prevalence at t-20, where t = 1951, 1961, 1971 and 1981) and sex differences in death rates at ages 40–44, 50–54 and 60–64 (measured as male/female death rate ratios at time t, where t = 1971, 1981, 1991 and 2000).[5] As shown in this Figure, the pattern or relationship between these variables reinforces the notion that sex differences in smoking prevalence in the past and current sex differences in all-cause mortality among Canadian adults are inversely related: The greater the ratio of female to male smoking prevalence at t-20 years ago, the lower the male/female death rate ratio at time t. Stated differently, as overall smoking prevalence for females goes up in relation to men, the relative risk of mortality for men at approximately twenty years later declines, presumably as a function of slowed mortality improvements in women due to their increased rates of smoking-related morbidity and mortality.

Conclusion

In Canada, as in other industrialized countries, the sex differential in life expectancy at birth widened during most of the 20th century. However, a narrowing of this differential has occurred recently. In this study we examined this situation for Canada. Decomposition analysis showed that a large portion of the decline in the sex gap in life expectancy between 1981 and 2000 was accounted for by reduced sex differences in mortality rate with respect to heart disease, lung cancer, accidents and violence (excluding suicide). The significant effects of heart disease and lung cancer uncovered here are consistent with the recent literature in this area, which shows that these causes of death are highly connected to tobacco use (Nathanson, 1995; Waldron, 1993; Pampel, 2002; 2003a; 2003b). Thus, increased smoking among women in conjunction with reduced smoking among men during the second half of the 20th century explains a large part of the decline in the sex differential in expectancy since the early 1980s. But smoking cannot explain the entire decline in this measure because, as indicated by the decomposition analysis, a substantial portion of the narrowing in the sex

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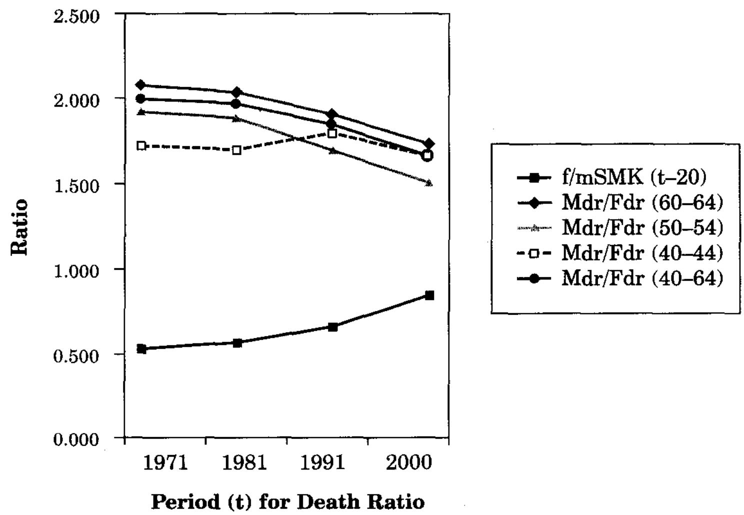
5. Smoking statistics for this part of the analysis are from Nicolaides-Bouman, Wald, Forey and Lee (1993). The age-specific death rate ratios were computed with data from the World Health Organization.

Figure 3

Relationship between Female/Male Smoking Prevalence Ratios Lagged by 20 Years (f/m SMK(t-20)), and Male/Female Age-Specific Death Rate Ratios (Mdr/Fdr) for Ages 40–44, 50–54, and 60–64, at Time (t) in Canada Where (t) for the Smoking Variable Is: 1951, 1961, 1971 and 1981; and for the Death Rate Ratio Is: 1971, 1981, 1991 and 2000



Note: Smoking data are from Nicolaides-Bouman, et al. (1993); death rate ratios computed with data from the World Health Organization (see text).

difference in life expectancy is attributable to men's larger improvements in mortality risk from accidents and violence.

We can think of at least two possibly contradictory reasons for this. First, men may be changing their conception of masculinity and may be gradually abandoning some of the more "lethal" traditional aspects of the male gender role. Perhaps they are becoming less aggressive and less inclined to take unnecessary risks; perhaps men are more aware of safety concerns. Should these tendencies be real, they would help explain the decline in male death rates from accidents and violence noted in this study and, to a lesser extent, from reductions in suicide and homicide since the early 1980s.[6]

On the other hand, male gains in life expectancy in recent decades may have resulted not from fundamental change in male gender role orientations and attitudes, but principally from the implementation of public health measures, which by their very nature influence men (and women) to change their behaviour. For example, one can think of mandatory safety belt legislation for drivers and mandatory use of helmets for bikers as public health measures that would have the effect of reducing the incidence of fatal accidents. Similarly, legislation prohibiting smoking in public places plus educational campaigns about its dangers to health may have lowered the desire for smoking in men. This type of explanation places the emphasis on forces external to men as the root agent of change.

We cannot at this time resolve these two contradictory possibilities without more in-depth sociological research. From our statistical analysis we can only establish that there has been a larger than expected reduction in mortality risk among men as compared to women from accidents and violence, lung cancer and heart disease and that these three causes of death explain most of the decline in the sex gap in life expectancy in Canada between 1981 and 2000.

One may speculate on the future course of the sex differential in life expectancy in Canada. It could potentially revert to its traditional pattern of widening differences in favour of women. There is recent evidence that, in Canada, the female smoking epidemic may have peaked. According to information presented in the Canadian Community Health Surveys for 2000–2001, 2003 and 2005 (Shields, 2006), the percentage of male and female smokers has been declining over these three periods (i.e., 28, 25 and 24%, respectively, for men; 24, 21 and 20%, respectively, for women). It may be too soon to say with certainty whether the reductions in female smoking will continue into the future, and whether the pace of decline will intensify. Should this trend continue, the sex gap in life expectancy may at some point begin to widen again (Pampel, 2002). An alternative perspective would see future trends in male and female life expectancy as being dependent not only on sex differences in smoking, but also on differences in other health behaviours, including diet, exercise, alcohol consumption and illicit drug use, as well as accidents and violence. Continued improvements in these risk factors in men should translate into further gains in male survival probabilities, even in a context of widespread decline in smoking among women. At the present time, it is impossible to know which of these two scenarios is more likely to prevail over the course of the 21st century.

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6. Maxim and Keane (1992) looked at the change in accidental and violent death rates for Canadian men and women between 1951 and 1986. Death rates between men and women during this period showed little, if any, convergence. Since declines in sex differences in mortality were just beginning to take shape in the 1980s, Maxim and Keane could not possibly have detected the convergent trends reported in the present analysis.

Appendix A

Decomposition Method

Assume life expectancy for males is totally determined by two causes of death. (Extension of the model to 10 causes of death would follow the same logic as described below.)

Define these as $\boldsymbol{A}$ and $\boldsymbol{B}$, where $\boldsymbol{A}$ = vector of age-specific death rates from heart disease, and $\boldsymbol{B}$ = vector of age-specific death rates for "all other" causes of death. The life expectancy for females is completely determined by the same two causes of death, defined as the vectors $\boldsymbol{a}$ and $\boldsymbol{b}$. Thus,

$$\mathbf{F(A, B)} = e^0{}_{males} \tag{1}$$
$$\mathbf{F(a, b)} = e^0{}_{females} \tag{2}$$

We calculate two new life expectancies at birth, F(a, B) and F(A, b). Consider the four differences:

$$\mathbf{F(a, b) - F(A, b)} \tag{3}$$
$$\mathbf{F(a, B) - F(A, B)} \tag{4}$$
$$\mathbf{F(A, b) - F(A, B)} \tag{5}$$
$$\mathbf{F(a, b) - F(a, B)} \tag{6}$$

The differences (3) and (4) can be attributed to the difference in heart disease rates for males and females since the "other" cause of death is held constant {as "$\boldsymbol{b}$" in (3) and as "$\boldsymbol{B}$" in (4)}. Similarly, the differences (5) and (6) can be attributed to the differences in "other causes" of females and males.

By adding these four life expectancies we get,

$$\begin{aligned}(3)+(4)+(5)+(6) &= \{\mathbf{F(a, b) - F(A, b)}\} + \{\mathbf{F(a, B) - F(A, B)}\} + \\ &\quad \{\mathbf{F(A, b) - F(A, B)}\} + \{\mathbf{F(a, b) - F(a, B)}\} \\ &= \mathbf{F(a, b) - F(A, B) + F(a, b) - F(A, B)} \\ &= 2\{\mathbf{F(a, b) - F(A, B)}\} \\ &= 2\{(e^0{}_{females} - e^0{}_{males})\} \end{aligned} \tag{7}$$

From equation (7) we can see that,

$$(e^0{}_{females} - e^0{}_{males}) = \frac{[\mathbf{F(a, b) - F(A, b) + F(a, B) - F(A, B)}]}{2} + \frac{[\mathbf{F(a, b) - F(a, B) + F(A, b) - F(A, B)}]}{2} \tag{8}$$

= effect of heart disease + effect of "other."

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