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Causes of Death Responsible for the Changing Sex Differential in Life Expectancy Between 1970 and 1990 in Thirty Industrialized Nations

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Abstract

In Western societies before the turn of this century life expectancy at birth for women was either below that of men or only slightly above. By the late 1920s and over the post-War years, the female advantage grew substantially, from approximately two to three years at the beginning of this period, to between five and seven years at present. During the last two decades, some nations have witnessed a constriction of this differential. For another set of countries the gender based gap in survival is still widening, but its magnitude has been getting smaller. In a third group of countries the life expectancy difference between men and women is relatively large and continues to diverge. We execute a decomposition analysis of sex differences in life expectancy at birth for thirty nations between 1970 and 1990. Our results indicate that although there are substantial variations by country with respect to magnitude of cause contribution, the most important cause-of-death components contributing to sex differencesin overall survival between 1970 and 1990 are heart disease (largest effect),accidents and violence excluding suicide, and lung cancer. In countries where there has been a narrowing of the sex gap, in comparison to women, men have tended to make larger improvements over time in terms of heart disease (male rates reducing more than those of females), accidents/violence excluding suicide (male rates reducing more than those of females), lung cancer (female rates going up while male rates reducing or not increasing as rapidly). In the closing section of this study we discuss what the future might hold for the sex differential in life expectancy in the industrialized world.

Résumé

Dans les sociétés occidentales au tournant du siècle, l'espérance de vie de la femme à la naissance était soit inférieure soit légèrement supérieure à celle de l'homme. Vers la fin des années 1920 et pendant l'après-guerre, l'avantage féminin a considérablement augmenté pour passer d'environ deux à trois ans au début de cette période et atteindre cinq à sept ans aujourd'hui. Depuis ces vingt dernières années, certains pays constatent une réduction de cette différence; tandis que pour d'autres le fossé continue à se creuser, quoique plus lentement. Dans un troisième groupe de pays, la différenced'espérance de vie entre hommes et femmes est relativement élevée et continue à diverger. Nous avons effectuéune analyse de décomposition portant sur l'écart entre les sexes dans l'espérance de vie à la naissance pour trente pays, de 1970 à 1990. Nos résultats indiquent que, bien qu'il existe des variations considérables d'un pays à l'autre quant à la gamme de causes possibles, les éléments majeurs des causes de décès contribuant aux différences entre les sexes durant la période visée sont les maladies cardiaques (effet principal), les accidents et la violence excepté le suicide, et le cancer du poumon. Dans les pays où le fossé diminue, les hommes semblent gagner du terrain sur le plan de la santé cardiaque (les taux d'affections diminuant plus vite chez l'homme que chez la femme), des accidents/de la violence excepté le suicide (les taux diminuant plus vite chez l'homme que chez la femme), du cancer du poumon (les taux étant à la hausse chez la femme alors qu'ils baissent ou augmentent moins vite chez l'homme blanc). Dans la conclusion de notre étude, nous examinons ce que l'avenir pourrait réserver concernant cette différenced'espérance de vie entre hommes et femmes dans le monde industrialisé.

Key words: *Sex difference, Expectation of life, Cause of death, Decomposition*

Introduction

One of the most entrenched differentialsin humans is the female advantage in survival over males (Madigan, 1957; Lopez, 1983; Waldron, 1976, 1983, 1993; Stolnitz, 1956; Retherford, 1975; Enterline, 1961; Preston, 1976, 1977; Nathanson, 1984; Wingard, 1984; Vallin, 1993, 1983; Verbrugge, 1976). Over the course of the present century this phenomenon has become universal. Currently, the female lead is in the order of five to seven years, depending on the country (Population ReferenceBureau, 1993).[1] After a relatively long phase of continued divergence, some nations have been experiencing a constriction of the difference in life expectancy, representing what appears to be an emerging feature of the fourth stage of epidemiologic transition.[2]

In this study, we examine the contribution of cause-specific mortality to the changing sex differential in life expectancy across thirty industrialized nations between 1970 and 1990, focusing primarily on the contribution of causes of death to any observed change in this differential. We address the following questions: (1) What is the relative contribution of causes of death to sex differences in life expectancy during a given time period? (2) Which causes of death have been either responsible for the narrowing or widening of the sex gap in survival over time? (3) How do the contributions of given causes vary across nations? In the closing segments of the study we discuss our findings in the context of epidemiological transition theory. We begin our analysis with an overview of the trends in this differential over the last two decades, followed by a decomposition analysis of cause-of-death component contributions to the change.

Sex Differences in Life Expectancy: Temporal Trends

Table 1 displays sex-specific life expectancies for thirty nations for 1970, 1980 and 1990, based on data from the World Health Organization (WHO, 1995). The period-specific differences in life expectancy are expressed as the female minus the male value, denoted in the table as D1, D2, and D3, respectively. The second-order differences of these measures indicate whether the sex gap in a given society has been widening or narrowing over time (i.e., D2-D1, and D3-D2) and by how much. As shown at the bottom of the table, overall, life expectancies of men and women have been increasing: In 1970 men could expect to live to an age of 68.672 years, and women 74.789, for an average difference of 6.116 years in favor of females. By 1990, men's lives were extended by an average of 3.706 years, reaching an overall expectancy of 72.378; women, on the other hand, had added 4.171 years to their life expectation, ending with an average of 78.960 in 1990. Thus in an overall sense, women continue to make greater strides in survival as compared to men.

The average first-order difference as shown at the bottom of Table 1 (D1) changed from 6.116 in 1970 to 6.602 in 1980, accounting for a net average widening over this interval by .486 of a year (D2-D1). However, between 1980 and 1990, this difference had actually narrowed by a small fraction (-.02). It is clear that this overall constriction was the result of some nations having had varying degrees of narrowing over time, while others continued on the usual path of divergence. In fact, over the most recent decade, 16 of the thirty countries show negative values of D3-D2, ranging from -1.03 in Australia, to -.118 in Belgium. For Scotland and England this trend began a decade earlier (see D2-D1 column). Taken as a group, the average amount of narrowing for these 16 countries between 1980 and 1990 is of the order of half a year (see row titled "negatives").

Table 1. Sex Differential in Life Expectancy and its Change Between Early 1970s and Early 1990s

Country	1970			1980			1990				
	e0m	e0f	D1	e0m	e0f	D2	e0m	e0f	D3	D2-D1	D3-D2
Australia	67.955	74.723	6.768	71.334	78.501	7.166	74.541	80.677	6.136	0.398	-1.030
Iceland	70.870	76.690	5.820	73.892	80.115	6.223	75.735	81.039	5.303	0.403	-0.920
Canada	69.479	76.649	7.170	71.914	79.244	7.329	74.438	80.999	6.561	0.159	-0.768
Finland	66.266	74.694	8.428	69.694	78.355	8.662	71.387	79.386	7.999	0.234	-0.663
USA	67.229	74.732	7.503	70.299	78.001	7.703	71.906	78.973	7.067	0.200	-0.636
Netherlands	70.980	76.872	5.891	72.734	79.598	6.863	74.136	80.396	6.260	0.972	-0.603
Norway	71.240	77.540	6.300	72.627	79.552	6.925	73.926	80.263	6.337	0.625	-0.588
Austria	66.732	73.803	7.071	69.277	76.458	7.181	72.754	79.355	6.601	0.110	-0.580
Denmark	70.841	76.160	5.318	71.480	77.625	6.145	72.536	78.111	5.575	0.827	-0.570
N. Ireland	68.217	74.255	6.039	69.169	75.579	6.410	72.442	78.331	5.889	0.371	-0.521
Sweden	72.184	77.583	5.399	73.164	79.326	6.161	75.141	80.818	5.678	0.762	-0.483
Scotland	67.649	74.122	6.473	69.104	75.249	6.145	71.476	77.216	5.740	-0.328	-0.405
England/Wales	69.296	75.599	6.304	71.180	77.179	5.999	73.524	79.182	5.658	-0.305	-0.341
West Germany	67.598	74.044	6.446	70.283	77.034	6.751	73.024	79.500	6.476	0.305	-0.275
New Zealand	68.641	74.703	6.062	70.420	76.603	6.183	72.716	78.748	6.032	0.121	-0.151
Belgium	68.065	74.545	6.480	70.140	77.012	6.871	72.372	79.125	6.753	0.391	-0.118
Italy	68.821	75.045	6.224	71.581	78.241	6.660	73.730	80.469	6.739	0.436	0.079
Malta	68.591	72.676	4.085	68.696	73.150	4.454	73.626	78.202	4.577	0.369	0.123
France	69.135	76.850	7.715	71.026	79.272	8.246	73.580	81.991	8.411	0.531	0.165
Ireland (Republic)	68.852	73.643	4.791	70.193	75.727	5.533	72.323	78.024	5.700	0.742	0.167
Portugal	63.939	70.449	6.509	68.503	75.524	7.021	70.517	77.745	7.229	0.512	0.208
Switzerland	70.415	76.561	6.146	72.593	79.370	6.777	74.284	81.326	7.042	0.631	0.265
Yugoslavia	65.694	70.599	4.906	67.949	73.578	5.629	69.139	75.157	6.019	0.723	0.390
Czechoslovakia	66.712	73.699	6.987	67.059	74.443	7.384	67.653	75.603	7.950	0.397	0.566
Greece	72.119	76.429	4.310	73.450	78.048	4.599	74.721	79.996	5.275	0.289	0.676
Poland	66.797	73.842	7.045	66.922	75.202	8.280	66.527	75.666	9.139	1.235	0.859
Japan	70.218	75.663	5.446	74.079	79.636	5.556	76.281	82.708	6.426	0.110	0.870
Spain	70.188	75.612	5.424	72.829	79.035	6.206	73.572	80.819	7.248	0.782	1.042
Bulgaria	68.863	73.420	4.557	68.704	74.225	5.521	68.367	75.025	6.658	0.964	1.137
Hungary	66.583	72.460	5.877	65.648	73.132	7.484	64.980	73.958	8.977	1.607	1.493
Mean											
Negatives*	68.953	75.420	6.467	71.044	77.839	6.795	73.253	79.507	6.254	0.328	-0.541
Positives#	68.352	74.068	5.716	69.945	76.327	6.382	71.379	78.335	6.956	0.666	0.574
All	68.672	74.789	6.116	70.531	77.134	6.602	72.378	78.960	6.582	0.486	-0.020
S. D.											
Negatives*	1.798	1.299	0.795	1.496	1.487	0.714	1.293	1.118	0.670	0.359	0.249
Positives**	2.175	2.073	1.114	2.685	2.495	1.227	3.486	2.911	1.344	0.395	0.448
All	1.971	1.808	1.014	2.168	2.127	0.991	2.686	2.191	1.081	0.408	0.665

* All countries where the sex gap narrowed in 1980-1990.

** All countries where the sex gap widened in 1980-1990.

These nations are situated in either Northern or Western Europe (Iceland, Finland, Netherlands, Norway, Austria, Denmark, Northern Ireland, Sweden, Scotland, England, West Germany, Belgium) or in the Anglo-Saxon overseas societies of Australia, Canada, USA, and New Zealand. In this analysis, we define these nations as Group A. What seems common to these populations are the following characteristics: (1) they have relatively high life expectancies for both genders across all three time points; (2) the average female expectancies tend to be over 75 at the beginning of this interval and in some cases surpass 80 at the end of the period; (3) the average gain in male life expectancy over the twenty-year interval is larger than that experienced by females (male gain = 4.3 years, female gain = 4.09 years); (4) over time, these nations as a whole experienced a declining level of dispersion in their average sex gaps, as demonstrated at the bottom of Table 1 by the changes in standard deviations for D1, D2, and D3.

From the last column in Table 1 we can identify two additional sets of countries. Group B consists of Italy, Malta, France, Republic of Ireland, Portugal, Switzerland, and Yugoslavia (former nation before breakup). These societies are characterized by a continuation of divergence in the sex differential, with the important qualification that between 1980 and 1990 a noticeable slowdown took place in this trend. For example, during the 1970s the differential in Italy had widened by 0.436 of a year (see D2-D1 column); and in the subsequent decade the gap reduced to only 0.079. Malta, France, Irish Republic, Portugal, Switzerland, and Yugoslavia portray a similar pattern. A common feature among Group B societies is the tendency for female expectancy to have risen faster than that of their male counterparts over the last twenty years: The average gain for males during the first decade was 5.65 years, while that of females was 6.52, for a differential of 0.87 of a year in favor of females. Another common characteristic is the relatively high levels of female life expectancy, which do not differ greatly from those in the preceding group.

Group C comprises the Eastern European nations of Czechoslovakia (now Czech Republic), Poland, Bulgaria and Hungary, as well as Greece and Spain in Southern Europe, and Japan. Beside the uniform experience of widening sex differences in survival over the last twenty years, women in these societies have enjoyed larger temporal gains in life expectation than their male counterparts. In the four former Communist countries, male expectancies have tended to erode over time, while those of females have continued to rise steadily (in Poland this occurred between 1980 and 1990). Bulgarian males in 1970 had a life expectancy of 68.863, but by 1990 this figure had reduced to 68.367, for a loss of almost half a year. In Hungary, the loss for men was even more pronounced, at 1.602 years. Between 1980 and 1990, Hungary and Bulgaria shared the largest survival divergences between the sexes (1.493 and 1.137, respectively). The Polish case is interesting because even though the sex gap remains substantial, the differential has actually reduced, from 1.235 in the earlier decade,

to .859 in the most recent decennial interval (nevertheless it is one of the largest divergences among countries). The situation in Greece, Spain and Japan, differs somewhat from the Eastern European nations in that the male and female life expectancies tend to be substantially higher, and are generally in line with the countries in Groups A and B. Japan represents a very interesting case because since 1980 its men and women enjoy the highest life expectancies in the world. Beside the uniform experience of widening sex differencesin survival over the last twenty years, women in these societies have enjoyed larger temporal gains in life expectation.

Decomposition Analysis

We employ a statistical model to decompose period-specific gender differences in life expectancy (e0) attributable to the relative contribution of 10 major causes of death, classified as follows: C1= heart disease; C2= other circulatory diseases; C3= lung cancer; C4= breast cancer; C5= prostate cancer; C6= other cancers; C7= cirrhosis of the liver; C8= other accidents and violence excluding suicide; C9= suicide; and C10= all other causes of death (residual). We first examine the relative importance of these ten cause components in explaining the sex differential in life expectancy in 1970, 1980, and 1990. This is followed by an analysis of the contribution of cause-of-death components to the change in gender differencesin life expectancy in order to identify which of the ten causes is/are responsible for either a widening or a narrowing of the sex gap over time (i.e., between 1970 and 1980, and between 1980 and 1990).

To illustrate the first aspect of decomposition, consider a hypothetical case where mortality is a function of only two causes of death. In the context of a multiple decrement life table, the expectation of life at birth in this case will be a function of the cause-specific probabilities of death for the two causes from infancy through to the last age in the life table. That is,

$$\mathbf{e^0}\,(\text{males}) = F(\mathbf{A}, \mathbf{B}) \quad (1)$$

$$\mathbf{e^0}\,(\text{females}) = F(\mathbf{a}, \mathbf{b}) \quad (2)$$

Where **A** and **B** are the vectors of age-specific probabilities of death (which are obtained from multiple decrement life table) from causes 1 and 2 for males; and **a** and **b** are the corresponding vectors for females. Thus, the sex differencein expectation of life can be decomposed into two cause components (Das Gupta, 1993):

$$\begin{aligned}\text{Difference in } e^0 &= F(\mathbf{a}, \mathbf{b}) - F(\mathbf{A}, \mathbf{B}) \\ &= [F(\mathbf{a}, \mathbf{b}) - F(\mathbf{A}, \mathbf{b}) + F(\mathbf{a}, \mathbf{B}) - F(\mathbf{A}, \mathbf{B})]/2 \\ &+ [F(\mathbf{a}, \mathbf{b}) - F(\mathbf{a}, \mathbf{B}) + F(\mathbf{A}, \mathbf{b}) - F(\mathbf{A}, \mathbf{B})]/2 \qquad (3)\end{aligned}$$

The first and second components are attributable to the first and second causes of death respectively; and the sum of the two components will therefore add up to the total gender difference in life expectancy. In our analysis there are ten causes of death, and therefore the formula for decomposition will be more complex than the one shown above (see Das Gupta, 1993). In substantive terms, each component represents its net contribution to the sex differencein life expectancy at age zero as a function of sex difference in that cause of death if all other causes were held constant simultaneously (i.e. standardized). Components with positive values would indicate that the sex mortality differential for that cause of death serves to increase the female advantage in life expectancy over males, whereas a negative value would reflect the opposite effect. Note that this decomposition analysis is based on multiple decrement life tables; therefore, our statistical results are net of age compositional differences.

The second aspect of decomposition analysis involves taking the change in contribution over time of a given cause component to the change in overall sex gap in life expectancy. In this case, a positive sign associated with a given component would indicate that the net effect of temporal change in the sex difference in mortality due to a given cause serves to expand the sex gap; and a negative sign would denote the opposite. In our statistical tables these effects are presented as absolute contributions in terms of years of life expectation (or fractionthereof).

1970 Period

Table 2 shows country-specific decompositions of life gender differencesin life expectancydifferences during 1970 across thirty industrialized nations. On the average, for the sixteen countries in Group A, sex differencesin heart disease accounted for approximately 40 per cent of the female advantage in average length of life (see bottom panel of Table 2), representing the main determinant of the differentialduring this period. The contribution of accidents and violence excluding suicide, accounted for an additional 18.30 per cent of the observed sex gap, and lung cancer for another 10.50 per cent. Since breast cancer is a disease predominantly confined to women, the effect of this component alone (net of all other causes of death) would have reversed the observed average sex gap by 6.76 percent or .36 of a year (i.e. -6.76 percent of 6.47). With the exception of the substantial contribution by the residual component (19.43%) the remaining causes appear to have played, on the average, minor roles individually in accounting for the observed sex difference in overall survival.

Table 2. Decomposition of Cause-of-Death Contribution to Female-Male Difference in Life Expectancy at Age Zero in 1970 for Thirty Industrialized Countries

	Country	e0F-M	Cause of Death Component (%)*									
		1970	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
1	Australia	6.77	42.51	4.41	8.92	-5.32	2.82	4.72	1.32	18.19	3.03	19.41
2	Iceland	5.82	54.78	9.96	-0.79	-9.55	4.66	1.27	0.17	32.31	3.65	3.54
3	Canada	7.17	41.23	5.50	9.50	-6.88	3.18	4.80	2.02	19.73	3.80	17.11
4	Finland	8.43	39.28	4.57	10.90	-2.96	1.71	4.66	0.75	19.70	6.78	14.63
5	USA	7.50	40.31	5.43	8.60	-5.50	2.59	4.19	2.57	21.27	2.94	17.60
6	Netherlands	5.89	38.23	4.44	20.02	-9.21	3.62	5.32	0.66	14.49	1.37	21.07
7	Norway	6.30	41.43	5.72	4.99	-5.70	4.38	5.34	0.56	19.76	2.72	20.82
8	Austria	7.07	24.02	7.13	9.39	-4.40	2.16	4.47	6.26	23.79	6.02	21.16
9	Denmark	5.32	44.03	4.68	12.35	-10.06	3.79	2.38	1.27	14.66	5.26	21.63
10	N. Ireland	6.04	47.57	3.33	11.48	-7.21	2.30	4.89	0.19	15.39	0.88	21.19
11	Sweden	5.40	44.39	4.60	6.08	-7.60	5.97	3.17	2.28	16.91	6.94	17.27
12	Scotland	6.47	42.87	5.38	16.06	-6.66	2.06	4.57	0.31	13.84	1.28	20.29
13	England/Wales	6.30	43.33	5.99	16.33	-8.13	2.50	4.80	0.20	8.82	1.20	24.97
14	West Germany	6.45	27.67	6.65	9.77	-5.23	2.67	3.76	4.70	18.91	4.67	26.43
15	New Zealand	6.06	46.11	3.10	9.83	-7.38	3.11	5.27	0.73	18.81	2.23	18.20
16	Belgium	6.48	30.16	6.79	14.62	-6.39	2.72	5.93	1.47	16.20	2.98	25.53
17	Italy	6.22	19.88	8.64	10.25	-5.68	2.54	11.69	7.78	17.88	1.41	25.60
18	Malta	4.09	30.02	16.52	14.23	-9.93	2.32	7.06	2.71	17.30	0.36	19.42
19	France	7.72	16.69	9.75	7.01	-4.42	2.86	14.63	6.03	18.32	3.80	25.33
20	Ireland Rep	4.79	44.33	3.20	10.03	-9.06	3.36	4.38	0.31	17.53	1.30	24.63
21	Portugal	6.51	11.25	8.80	2.54	-3.86	2.18	5.69	6.31	23.44	2.80	40.86
22	Switzerland	6.15	25.00	5.94	11.82	-7.48	4.42	8.54	4.54	21.10	6.11	20.02
23	Yugoslavia	4.91	15.37	4.03	7.40	-3.42	1.74	5.45	4.25	31.95	**	33.23
24	Czechoslovakia	6.99	26.26	6.92	12.36	-4.02	1.69	6.18	3.06	17.48	7.37	22.70
25	Greece	4.31	20.07	1.03	12.99	-5.65	2.44	14.61	5.47	19.71	1.36	27.98
26	Poland	7.05	22.13	7.77	7.85	-3.06	1.62	5.44	1.41	19.87	5.28	31.69
27	Japan	5.45	10.72	23.32	3.65	-1.73	0.54	13.15	4.51	21.33	2.45	22.05
28	Spain	5.42	18.58	9.54	6.43	-4.09	3.19	9.54	5.92	18.14	1.67	31.06
29	Bulgaria	4.56	13.53	3.04	10.94	-4.42	2.00	8.15	1.45	25.56	3.68	36.08
30	Hungary	5.88	25.60	7.83	8.59	-4.77	2.82	5.50	2.23	17.63	10.93	23.66
	Mean(1-16)	6.47	40.49	5.48	10.50	-6.76	3.14	4.35	1.59	18.30	3.48	19.43
	S. D.	0.80	7.67	1.65	4.92	1.92	1.11	1.19	1.72	5.13	1.97	5.31
	Mean(17-23)	5.77	23.22	8.13	9.04	-6.26	2.77	8.21	4.56	21.07	2.25	27.01
	S. D.	1.24	11.21	4.47	3.79	2.59	0.89	3.73	2.49	5.30	2.16	7.61
	Mean(24-30)	5.66	19.56	8.49	8.97	-3.96	2.04	8.94	3.44	19.96	4.68	27.89
	S. D.	1.07	5.83	7.19	3.36	1.26	0.88	3.71	1.88	2.83	3.48	5.33
	Mean(1-30)	6.12	31.58	6.80	9.80	-5.99	2.80	6.32	2.71	19.33	3.47	23.17
	S. D.	1.01	12.61	4.28	4.29	2.23	1.08	3.34	2.28	4.74	2.49	7.01

*The cause of death components are as follows: (1) Heart Disease, (2) Other Circulatory, (3) Lung Cancer, (4) Breast Cancer, (5) Prostate Cancer, (6) Other Cancer, (7) Cirrhosis of Liver (8) Accidents and Violence excluding suicide, (9) Suicide, (10) All Other Causes.

** This cause of death not available in the data file.

Being averages, these figures tend to mask important variations when individual nations are examined. For example, Iceland shows heart disease accounting for 54.8 per cent (the largest contribution for this disease), while in Austria this is only 24 per cent. The largest contribution of lung cancer is in the Netherlands (20%), while the lowest is in Iceland (-.8%), where the contribution served to narrow the sex gap rather than to increase it. Denmark exhibited the largest effectof breast cancer (-10.06%), while the lowest contribution is in Finland (-3%). Accidents and violence excluding suicide accounted for roughly 32 per cent of the survival gap in Iceland, but only approximately 9 per cent in England/Wales. These varying levels of effectssuggests that for the most part, during 1970 higher male death rates from heart disease (the most important cause), as well as accidents/violence and lung cancer were responsible for the gender based survival differential.

The bottom panel of Table 2 indicates that in Groups B and C, the relative contribution of heart disease (23.22 and 19.56 per cent, respectively) is substantially lower than in Group A. This generalization is also true in connection with cancers of the lung, prostate and of the breast. However, the influences of other circulatory ailments, other cancers, cirrhosis of the liver, accidents/violence, suicide, and residual were more pronounced. Thus, in the second and third sets of nations, higher male death rates from these causes constituted the predominant reason underlying the differencein life expectancy between men and women in 1970 (corresponding sex-specific age-standardized death rates by cause of death available on request). The larger contribution of residual causes in Group C may reflectthe combined influences of higher male infant and childhood mortality and perhaps also infectious diseases. (i.e., this component contains such causes of death).

1980 Period

In Table 3, the relative contributions of most cause components for all three groups of nations in 1980 tended to be larger as compared to the situation in 1970 (compare Tables 2 and 3). Exceptions to this tendency are the categories of accidents/violence and residual causes (and suicide in Group C). The overall trends between these two time points suggest that women continued to enjoy larger improvements in survival from virtually all the major killers, though cancer mortality among women increased during the period, as the negative value of this component became larger in 1980.

With few exceptions, the overall net effectsof cause components between 1970 and 1980 served to expand the sex gap in life expectancy across all three groups of nations. This trend is reflected more clearly in Table 4, which presents decomposition of change in the sex differencein life expectancy as a function of change in cause-of-death components. Note that the figures in the table represent contributions to the change in the sex gap in terms of absolute years of life

Table 3. Decomposition of Cause-of-Death Contribution to Female-Male Difference in Life Expectancy at Age Zero in 1980 for Thirty Industrialized Countries

	Country	e0F-M	Cause of Death Component (%)*									
		1980	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
1	Australia	7.17	38.39	5.71	11.04	-5.98	3.70	9.09	2.32	14.77	4.06	16.89
2	Iceland	6.22	56.11	6.71	2.88	-7.60	5.79	7.79	0.03	17.50	5.34	5.46
3	Canada	7.33	38.21	5.50	12.08	-7.30	3.90	8.07	2.56	15.43	5.38	16.17
4	Finland	8.66	41.65	6.18	12.03	-3.50	2.63	4.82	1.31	14.09	7.90	12.89
5	USA	7.70	38.62	4.45	10.67	-6.34	3.63	7.10	2.62	19.35	4.06	15.84
6	Netherlands	6.86	37.02	6.32	22.31	-8.62	4.29	9.72	1.05	7.51	1.72	18.69
7	Norway	6.93	41.95	6.11	6.75	-5.72	5.26	4.86	1.13	14.18	4.61	20.88
8	Austria	7.18	29.63	7.22	9.83	-5.37	2.94	7.66	6.86	17.92	7.99	15.33
9	Denmark	6.15	43.68	6.15	12.19	-8.67	4.66	3.96	2.38	10.10	6.61	18.95
10	N. Ireland	6.41	48.39	4.47	10.05	-7.94	2.50	4.91	0.38	16.87	1.70	18.68
11	Sweden	6.16	49.69	5.93	5.70	-6.83	5.59	4.42	2.42	12.31	5.85	14.91
12	Scotland	6.15	44.19	5.42	14.63	-8.42	2.58	7.17	0.93	12.78	2.65	18.08
13	England/Wales	6.00	46.52	5.97	15.22	-9.64	3.22	7.54	0.35	8.44	2.16	20.22
14	West Germany	6.75	33.85	7.32	11.61	-6.26	3.42	8.59	5.40	11.82	5.27	19.01
15	New Zealand	6.18	43.13	5.15	10.38	-8.65	4.18	7.70	1.29	15.31	3.78	17.73
16	Belgium	6.87	26.45	7.88	18.85	-7.61	3.65	9.74	1.91	13.39	4.52	21.23
17	Italy	6.66	24.46	8.16	15.12	-6.38	2.81	14.46	7.57	13.62	1.85	18.34
18	Malta	4.45	39.88	15.57	12.78	-10.31	2.75	9.42	2.93	11.95	0.07	14.97
19	France	8.25	17.29	8.13	10.15	-5.13	3.40	19.73	5.13	14.76	4.83	21.70
20	Ireland Rep	5.53	46.65	4.48	9.39	-9.47	3.32	7.63	0.29	16.06	2.56	19.09
21	Portugal	7.02	13.27	11.69	4.16	-4.39	2.58	9.25	7.06	26.60	1.90	27.90
22	Switzerland	6.78	31.07	6.36	13.80	-7.87	5.49	10.56	3.38	14.46	7.43	15.33
23	Yugoslavia	5.63	22.33	5.76	10.16	-4.28	2.31	8.39	6.21	19.99	4.78	24.34
24	Czechoslovakia	7.38	29.94	8.89	13.23	-4.25	1.85	8.82	4.16	13.35	5.72	18.29
25	Greece	4.60	28.27	1.88	17.62	-7.58	2.79	13.65	3.69	19.43	1.39	18.86
26	Poland	8.28	27.61	9.62	10.25	-3.37	1.43	7.14	1.87	22.74	**	22.70
27	Japan	5.56	15.13	16.28	7.19	-2.51	1.03	20.46	5.49	13.30	5.03	18.60
28	Spain	6.21	22.48	7.74	11.05	-5.27	3.62	14.40	6.73	14.68	1.80	22.77
29	Bulgaria	5.52	23.79	11.39	9.73	-4.62	1.54	6.46	2.83	20.55	3.66	24.67
30	Hungary	7.48	27.51	11.16	9.79	-4.47	2.19	7.97	4.79	13.73	9.54	17.80
	Mean(1-16)	6.79	41.09	6.03	11.64	-7.15	3.87	7.07	2.06	13.86	4.60	16.93
	S. D.	0.71	7.49	0.95	4.71	1.57	1.04	1.90	1.81	3.33	1.95	3.81
	Mean(17-23)	6.33	27.85	8.59	10.79	-6.83	3.24	11.35	4.65	16.78	3.34	20.24
	S. D.	1.23	12.07	3.84	3.62	2.44	1.06	4.31	2.60	5.00	2.47	4.73
	Mean(24-30)	6.43	24.96	9.56	11.27	-4.58	2.06	11.27	4.22	16.83	3.88	20.53
	S. D.	1.32	5.06	4.35	3.33	1.60	0.89	5.12	1.63	3.96	3.22	2.77
	Mean(1-30)	6.60	34.24	7.45	11.35	-6.48	3.30	9.05	3.17	15.23	4.14	18.54
	S. D.	0.99	11.00	3.15	4.07	2.05	1.23	3.97	2.26	4.05	2.38	4.10

*The cause of death components are as follows: (1) Heart Disease, (2) Other Circulatory, (3) Lung Cancer, (4) Breast Cancer, (5) Prostate Cancer, (6) Other Cancer, (7) Cirrhosis of Liver (8) Accidents and Violence excluding suicide, (9) Suicide, (10) All Other Causes.

** This cause of death not available in the data file.

expectancy (or fraction thereof), and that the sum of the ten causes will add up to the observed overall change in the sex gap.

On the whole, during this time interval, Group A countries experienced a widening of .328 of a year in the sex gap, while those in Groups B and C showed larger changes of .563 and .769, respectively (see bottom of Table 4). The dominant components for these overall expansions tend to be the same across the three sets of countries, though the rank order of importance may differ. Among Group A nations, the following causes led to a widening of the differential: heart disease (.172), other circulatory (.055), lung cancer (.114), prostate cancer (.063), other cancers (.197), cirrhosis of the liver (.037), and suicide (.090). Negative effects can be attributed to accidents/violence excluding suicide (-.241), residual causes (-.107), and breast cancer (-.052).

As shown in Table 3, by 1980 the countries in group B had experienced a shift in the primacy of importance for given cause contributions. During 1970 the residual category led the way, but in 1980 almost 28 per cent of the sex differential in survival could be attributed to men's higher death rates from heart disease (the leading contributor). An additional 20 per cent was due to residual causes; and accidents/violence excluding suicide accounted for almost 18 per cent of the sex gap. Moreover, lung cancer and other cancers together were responsible for about 22 per cent of the differential.

Between 1970 and 1980, the pattern of change in contribution of cause-of-death components for Group B follows rather closely that of societies in Group A. There occurred rises or declines in degree of contribution for practically the same components, and in most cases by a similar amount. The most notable exceptions to this generalization are: heart disease, where the change in contribution is substantially greater in Group B, and residual causes, characterizedby a larger decline in this Group. Such differencein pattern of change and in levels of effectsbetween the two sets of nations provides some clue as to why the sex gap in life expectancy continued to widen by a larger amount between 1970 and 1980 in Group B. The answer lies in the greater positive contributions of heart disease in the latter group. During that decade men's death rates either increased more than those of women, or perhaps declined less, leading to an overall expansion of the gender gap in survival. (Table of age-standardized death rates available on request.)

Concerning Group C, in 1980 the average contribution of heart disease was 25 per cent, while residual and accidents/violence each contributed roughly 20 and 17 per cent, respectively; other cancers and lung cancer were each responsible for just over 11 per cent of the sex gap in survival. In general, what distinguishes the situation of this Group from that of the previous two is the greater weight of other circulatory complications (9.56 %), and the lower impacts of breast cancer (-4.58), prostate cancer (2.06 %), suicide (3.88 %), and also heart disease.

Table 4. Decomposition of Change in Female-Male Differences in Life Expectancy at Age Zero by Cause-of-Death Components for Thirty Industrialized Countries, Change Between 1970-1980

	Country	change in e0F-M	Cause of Death Component (%)*									
		(1980-1970)	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
1	Australia	0.398	-0.126	0.111	0.187	-0.068	0.074	0.332	0.078	-0.172	0.086	-0.104
2	Iceland	0.403	0.303	-0.163	0.225	0.083	0.090	0.411	-0.008	-0.791	0.120	0.134
3	Canada	0.159	-0.156	0.008	0.204	-0.042	0.058	0.248	0.043	-0.284	0.122	-0.042
4	Finland	0.234	0.297	0.150	0.124	-0.053	0.084	0.024	0.050	-0.439	0.113	-0.117
5	USA	0.200	-0.050	-0.064	0.177	-0.075	0.086	0.233	0.009	-0.105	0.092	-0.101
6	Netherlands	0.972	0.288	0.173	0.352	-0.048	0.081	0.353	0.033	-0.338	0.037	0.041
7	Norway	0.625	0.295	0.063	0.153	-0.037	0.088	0.001	0.043	-0.263	0.148	0.134
8	Austria	0.110	0.429	0.014	0.042	-0.075	0.058	0.234	0.051	-0.395	0.148	-0.395
9	Denmark	0.827	0.342	0.129	0.092	0.002	0.084	0.116	0.078	-0.159	0.126	0.014
10	N. Ireland	0.371	0.229	0.085	-0.049	-0.073	0.021	0.019	0.013	0.152	0.056	-0.082
11	Sweden	0.762	0.666	0.117	0.023	-0.011	0.022	0.101	0.026	-0.154	-0.015	-0.013
12	Scotland	-0.328	-0.059	-0.015	-0.141	-0.086	0.026	0.144	0.037	-0.111	0.080	-0.202
13	England/Wales	-0.304	0.060	-0.019	-0.116	-0.066	0.036	0.150	0.008	-0.050	0.053	-0.361
14	West Germany	0.305	0.501	0.065	0.153	-0.086	0.059	0.337	0.061	-0.421	0.055	-0.421
15	New Zealand	0.121	-0.128	0.130	0.045	-0.087	0.070	0.156	0.036	-0.193	0.099	-0.007
16	Belgium	0.391	-0.137	0.101	0.348	-0.109	0.075	0.285	0.036	-0.130	0.118	-0.195
17	Italy	0.436	0.391	0.005	0.369	-0.072	0.029	0.236	0.020	-0.206	0.035	-0.372
18	Malta	0.369	0.550	0.018	-0.012	-0.053	0.027	0.131	0.019	-0.175	-0.012	-0.126
19	France	0.531	0.137	-0.081	0.296	-0.082	0.060	0.498	-0.042	-0.196	0.105	-0.164
20	Ireland Rep	0.742	0.457	0.095	0.039	-0.090	0.023	0.212	0.001	0.049	0.080	-0.123
21	Portugal	0.512	0.199	0.247	0.126	-0.057	0.039	0.278	0.085	0.341	-0.049	-0.701
22	Switzerland	0.631	0.570	0.066	0.209	-0.073	0.100	0.191	-0.050	-0.317	0.127	-0.191
23	Yugoslavia	0.723	0.503	0.126	0.209	-0.073	0.045	0.206	0.141	-0.442	0.269	-0.260
24	Czechoslovakia	0.397	0.376	0.173	0.113	-0.033	0.019	0.219	0.093	-0.235	-0.093	-0.236
25	Greece	0.289	0.435	0.043	0.250	-0.106	0.023	-0.002	-0.066	0.044	0.005	-0.339
26	Poland	1.235	0.727	0.249	0.296	-0.063	0.004	0.209	0.056	0.483	-0.372	-0.353
27	Japan	0.110	0.257	-0.366	0.201	-0.046	0.027	0.421	0.059	-0.422	0.146	-0.168
28	Spain	0.782	0.387	-0.037	0.337	-0.105	0.052	0.376	0.097	-0.073	0.021	-0.272
29	Bulgaria	0.964	0.698	0.490	0.038	-0.054	-0.006	-0.014	0.090	-0.030	0.034	-0.283
30	Hungary	1.607	0.554	0.375	0.228	-0.054	-0.001	0.274	0.227	-0.009	0.072	-0.058
	Mean(1-16)	0.328	0.172	0.055	0.114	-0.052	0.063	0.197	0.037	-0.241	0.090	-0.107
	S. D.	0.359	0.259	0.090	0.143	0.046	0.025	0.127	0.024	0.211	0.044	0.171
	Mean(17-23)	0.563	0.401	0.068	0.177	-0.071	0.046	0.250	0.025	-0.135	0.079	-0.277
	S. D.	0.141	0.171	0.104	0.136	0.013	0.027	0.118	0.068	0.258	0.105	0.206
	Mean(24-30)	0.769	0.491	0.132	0.209	-0.066	0.017	0.212	0.079	-0.035	-0.027	-0.244
	S. D.	0.542	0.175	0.285	0.104	0.029	0.020	0.169	0.086	0.279	0.168	0.103
	Mean(1-30)	0.486	0.300	0.076	0.151	-0.060	0.048	0.213	0.044	-0.168	0.060	-0.179
	S. D.	0.407	0.260	0.156	0.136	0.037	0.030	0.133	0.057	0.246	0.107	0.180

*The cause of death components are as follows: (1) Heart Disease, (2) Other Circulatory, (3) Lung Cancer, (4) Breast Cancer, (5) Prostate Cancer, (6) Other Cancer, (7) Cirrhosis of Liver (8) Accidents and Violence excluding suicide, (9) Suicide, (10) All Other Causes.

Returning to Table 4, across all three groups of countries the contributions of heart disease between 1970 and 1980 exceeds that of any other component. Not surprisingly, then, in societies where men have been making larger improvements in heart disease as compared to women, the sex gap in expectation of life widened by a lower degree then in nations where the male improvement was less pronounced. This relationship is clearly evident in Group C countries, where the change in the sex gap in expectation of life ranges between 1.607 years (Hungary) and .11 of a year (Japan). The contribution of heart disease in these societies is consistently positive and generally quite substantial, as compared to societies in Group A, most notably in Australia, Canada, USA, Scotland, England, New Zealand and Belgium, where the effects of this killer are either negative or small positive. Although the sex gap has been expanding in these societies, the amount of change in the differential has tended to be smaller than nations in Group C (i.e., the gap is positive, but diminishing in magnitude over time).

1990 Period

If all the thirty nations are considered as a whole, the bottom part of Table 5 shows that heart disease in 1990 was the leading cause of the sex differential in overall survival (31.19 %). Following in order of importance were: residual (19.46 %), accidents/violence (13.51 %), lung cancer (11.83 %), and other cancers (11.71 %). In general, these rankings prevailed across all three sets of nations, though the magnitude of effects may differ. For example, in Group A, heart disease accounted for 36 per cent, while in Groups B and C, its contribution was somewhat lower at 26 and 25 per cent, respectively.

As noted earlier in Table 1, and now also evident in Table 6, between 1980 and 1990 Group A nations experienced an overall narrowing of the sex gap by -.541 of a year, while the other two groups continued to follow an expansionary trend (Group B by .200, and Group C by .949 of a year on average). What accounted for a large portion of the constriction in the former Group was the influence of heart disease, with a contribution of -.526 of a year. Following this component, the rank order of importance for those causes with negative values is as follows: accidents/violence excluding suicide (-.177), lung cancer (-.085), breast cancer (-.068), other circulatory (-.012) and cirrhosis of the liver (-.012).

These negative shifts in component contributions over the last decade generally reflect larger mortality improvements for men as compared to women. With the exception of breast cancer (which is a female affliction) the improvements in male life expectancy could have resulted from a number of possible temporal dynamics, including the likelihood that both sexes could have made gains in survival, but the gain favored men more; or alternatively, women could have experienced increased mortality from certain causes, while male death rates declined or remained stable. For the most part, the mechanism involved is a

Table 5. Decomposition of Cause-of-Death Contribution to Female-Male Difference in Life Expectancy at Age Zero in 1990 for Thirty Industrialized Countries

	Country	e0F-M	Cause of Death Component (%)*									
		1990	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
1	Australia	6.14	32.56	5.94	11.02	-8.32	6.37	13.08	2.20	11.00	6.91	19.25
2	Iceland	5.30	41.85	7.55	2.89	-11.97	9.49	12.27	0.42	18.94	10.02	8.54
3	Canada	6.56	31.50	5.37	12.77	-9.09	6.00	11.31	2.13	11.73	6.59	21.69
4	Finland	8.00	36.93	7.07	9.84	-4.57	3.75	4.83	2.53	16.39	10.89	12.34
5	USA	7.07	32.49	3.82	10.44	-7.52	4.95	9.03	2.35	16.69	5.40	22.35
6	Netherlands	6.26	32.35	7.70	20.31	-10.23	5.49	12.40	0.94	6.05	2.36	22.64
7	Norway	6.34	40.19	7.35	7.36	-7.00	6.93	8.07	1.00	10.80	6.11	19.20
8	Austria	6.60	30.21	6.45	11.19	-7.35	4.57	11.54	7.51	13.88	7.58	14.43
9	Denmark	5.58	37.81	6.73	9.15	-10.64	6.24	6.74	3.35	11.06	6.11	23.45
10	N. Ireland	5.89	43.70	4.54	11.26	-9.49	4.75	9.27	0.19	13.47	4.01	18.32
11	Sweden	5.68	43.34	8.47	5.58	-7.92	8.15	6.26	1.63	10.89	5.42	18.19
12	Scotland	5.74	41.39	5.71	12.70	-9.45	4.17	9.99	1.15	11.38	4.95	18.03
13	England/Wales	5.66	42.16	7.26	13.05	-11.37	5.92	11.56	0.79	8.73	3.91	18.01
14	West Germany	6.48	31.73	7.11	12.94	-8.08	4.74	12.61	4.11	8.54	4.58	21.72
15	New Zealand	6.03	38.63	4.87	8.61	-10.05	6.03	9.98	0.70	15.96	8.00	17.28
16	Belgium	6.75	22.56	6.35	20.07	-8.92	4.68	12.35	1.49	11.11	5.25	25.08
17	Italy	6.74	22.24	7.71	17.19	-7.43	3.53	17.94	4.99	12.80	2.24	18.79
18	Malta	4.58	30.97	3.78	17.63	-12.48	3.92	13.01	4.07	11.28	2.67	25.16
19	France	8.41	16.09	6.32	12.83	-6.08	4.56	22.48	3.35	12.52	5.39	22.53
20	Ireland Rep	5.70	43.42	5.53	9.32	-9.84	5.19	9.83	0.53	11.83	5.80	18.40
21	Portugal	7.23	13.66	10.64	6.01	-5.44	3.21	11.51	5.87	22.05	2.55	29.95
22	Switzerland	7.04	29.43	4.92	12.68	-8.37	6.82	11.91	2.06	14.57	7.06	18.94
23	Yugoslavia	6.02	24.97	6.89	12.49	-5.12	2.18	10.46	5.08	15.80	4.52	22.74
24	Czechoslovakia	7.95	30.90	9.82	13.20	-4.35	2.19	11.07	5.17	13.12	4.78	14.10
25	Greece	5.28	30.43	2.77	19.13	-7.01	3.27	14.17	2.67	18.71	1.75	14.12
26	Poland	9.14	26.92	12.02	11.09	-3.17	1.48	7.58	1.75	18.40	4.66	19.27
27	Japan	6.43	15.88	9.69	9.81	-2.95	1.57	24.25	3.80	10.84	4.05	23.05
28	Spain	7.25	18.18	5.88	14.14	-5.90	3.66	17.12	4.89	15.59	2.35	24.10
29	Bulgaria	6.66	28.99	13.65	9.32	-4.41	1.69	7.34	4.08	17.22	3.99	18.14
30	Hungary	8.98	24.40	10.80	10.94	-4.13	1.90	11.36	8.84	13.94	8.02	13.94
	Mean(1-16)	6.25	36.21	6.39	11.20	-8.87	5.76	10.08	2.03	12.29	6.13	18.78
	S. D.	0.67	5.96	1.27	4.48	1.84	1.50	2.53	1.81	3.40	2.21	4.29
	Mean(17-23)	6.53	25.82	6.54	12.59	-7.82	4.20	13.87	3.71	14.40	4.32	22.36
	S. D.	1.23	10.04	2.22	4.10	2.65	1.50	4.64	1.88	3.72	1.87	4.20
	Mean(24-30)	7.38	25.10	9.23	12.52	-4.56	2.25	13.27	4.46	15.40	4.23	18.10
	S. D.	1.41	5.97	3.72	3.39	1.45	0.87	5.95	2.27	2.93	2.03	4.30
	Mean(1-30)	6.58	31.19	7.09	11.83	-7.62	4.58	11.71	2.99	13.51	5.26	19.46
	S. D.	1.08	8.74	2.49	4.09	2.61	1.98	4.27	2.16	3.54	2.24	4.44

*The cause of death components are as follows: (1) Heart Disease, (2) Other Circulatory, (3) Lung Cancer, (4) Breast Cancer, (5) Prostate Cancer, (6) Other Cancer, (7) Cirrhosis of Liver (8) Accidents and Violence excluding suicide, (9) Suicide, (10) All Other Causes.

Table 6. Decomposition of Change in Female-Male Differences in Life Expectancy at Age Zero by Cause-of-Death Components for Thirty Industrialized Countries, Change Between 1980-1990

	Country	change in e0F-M (1990-1980)	Cause of Death Component (%)*									
			C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
1	Australia	-1.030	-0.753	-0.045	-0.115	-0.082	0.126	0.151	-0.032	-0.384	0.133	-0.029
2	Iceland	-0.920	-1.271	-0.017	-0.026	-0.162	0.142	0.166	0.020	-0.085	0.200	0.113
3	Canada	-0.768	-0.733	-0.051	-0.047	-0.062	0.108	0.150	-0.048	-0.361	0.038	0.238
4	Finland	-0.663	-0.653	0.031	-0.255	-0.062	0.072	-0.031	0.089	0.090	0.187	-0.129
5	USA	-0.636	-0.679	-0.073	-0.084	-0.044	0.070	0.091	-0.036	-0.311	0.069	0.359
6	Netherlands	-0.603	-0.515	0.048	-0.259	-0.050	0.050	0.109	-0.013	-0.136	0.029	0.135
7	Norway	-0.588	-0.358	0.042	-0.001	-0.047	0.075	0.174	-0.014	-0.298	0.068	-0.229
8	Austria	-0.580	-0.134	-0.092	0.033	-0.099	0.091	0.212	0.003	-0.371	-0.074	-0.149
9	Denmark	-0.570	-0.576	-0.003	-0.239	-0.060	0.062	0.133	0.041	-0.005	-0.066	0.142
10	N. Ireland	-0.521	-0.528	-0.019	0.019	-0.050	0.119	0.232	-0.013	-0.288	0.127	-0.119
11	Sweden	-0.483	-0.602	0.116	-0.034	-0.029	0.119	0.083	-0.056	-0.141	-0.052	0.114
12	Scotland	-0.405	-0.340	-0.006	-0.170	-0.026	0.080	0.133	0.009	-0.132	0.121	-0.076
13	England/Wales	-0.342	-0.406	0.053	-0.175	-0.065	0.142	0.201	0.024	-0.012	0.092	-0.194
14	West Germany	-0.275	-0.230	-0.033	0.055	-0.100	0.076	0.237	-0.098	-0.245	-0.060	0.123
15	New Zealand	-0.151	-0.337	-0.024	-0.122	-0.071	0.106	0.126	-0.038	0.016	0.248	-0.054
16	Belgium	-0.118	-0.294	-0.112	0.060	-0.080	0.065	0.165	-0.031	-0.170	0.043	0.234
17	Italy	0.079	-0.131	-0.024	0.152	-0.076	0.051	0.246	-0.168	-0.044	0.028	0.045
18	Malta	0.123	-0.359	-0.520	0.238	-0.112	0.057	0.176	0.056	-0.016	0.119	0.485
19	France	0.165	-0.072	-0.140	0.242	-0.088	0.102	0.264	-0.141	-0.164	0.056	0.105
20	Ireland Rep	0.167	-0.106	0.067	0.012	-0.037	0.112	0.138	0.014	-0.215	0.189	-0.008
21	Portugal	0.208	0.056	-0.051	0.143	-0.085	0.051	0.183	-0.072	-0.273	0.051	0.206
22	Switzerland	0.265	-0.034	-0.085	-0.042	-0.057	0.108	0.122	-0.084	0.046	-0.006	0.295
23	Yugoslavia	0.390	0.246	0.091	0.180	-0.067	0.001	0.156	-0.043	-0.175	0.003	-0.001
24	Czechoslovakia	0.566	0.245	0.125	0.073	-0.032	0.037	0.229	0.104	0.057	-0.042	-0.229
25	Greece	0.676	0.305	0.059	0.199	-0.021	0.044	0.120	-0.029	0.094	0.028	-0.122
26	Poland	0.859	0.174	0.303	0.165	-0.010	0.017	0.100	0.005	-0.202	0.426	-0.119
27	Japan	0.870	0.180	-0.281	0.230	-0.049	0.044	0.422	-0.061	-0.042	-0.019	0.448
28	Spain	1.042	-0.078	-0.055	0.339	-0.101	0.040	0.347	-0.064	0.219	0.058	0.334
29	Bulgaria	1.137	0.616	0.280	0.084	-0.038	0.027	0.131	0.116	0.011	0.064	-0.154
30	Hungary	1.493	0.132	0.134	0.249	-0.037	0.007	0.423	0.435	0.224	0.006	-0.081
	Mean(1-16)	-0.541	-0.526	-0.012	-0.085	-0.068	0.094	0.146	-0.012	-0.177	0.069	0.030
	S. D.	0.249	0.271	0.059	0.110	0.033	0.029	0.066	0.044	0.151	0.099	0.175
	Mean(17-23)	0.200	-0.057	-0.095	0.132	-0.075	0.069	0.184	-0.063	-0.120	0.063	0.161
	S. D.	0.103	0.185	0.204	0.109	0.024	0.041	0.053	0.080	0.117	0.069	0.181
	Mean(24-30)	0.949	0.225	0.081	0.191	-0.041	0.031	0.253	0.072	0.052	0.074	0.011
	S. D.	0.310	0.210	0.202	0.094	0.029	0.014	0.143	0.176	0.150	0.160	0.266
	Mean(1-30)	-0.020	-0.241	-0.009	0.030	-0.063	0.073	0.180	-0.004	-0.110	0.069	0.056
	S. D.	0.665	0.399	0.150	0.163	0.032	0.039	0.095	0.105	0.168	0.107	0.202

*The cause of death components are as follows: (1) Heart Disease, (2) Other Circulatory, (3) Lung Cancer, (4) Breast Cancer, (5) Prostate Cancer, (6) Other Cancer, (7) Cirrhosis of Liver (8) Accidents and Violence excluding suicide, (9) Suicide, (10) All Other Causes.

decline in both male and female rates, with those of males reducing more over time. (Standardized death rates available on request.)

Regardless, the tendency for the sex gap to narrow suggests that the sexes may be experiencing shifts in modes of living that differradically from the past, and that such changes have translated into a converging trend in mortality. For example, the larger improvement in lung cancer for males probably signifies the effects of widespread smoking cessation during the post-War years, in conjunction with increased use of tobacco by women (Lopez, 1995; Wingard, 1985; Chollat-Traquet, 1992; Waldron, 1993). Undoubtedly, the decline in smoking prevalence is also of significance in men's survival gains from heart disease (Goldman and Cook, 1988).

In Country Group A, four cause components are conspicuous in their contributions to enlarging the female survival advantage: prostate cancer (.094), other cancers (.146), suicide (.079) and residual causes (.030). "Other cancers" and prostate cancer also figure prominently in this trend. Although its contribution to the sex gap in life expectancy tends to be relatively small, male suicide continues to be a significant concern in many industrialized societies (Vallin, 1993).

If one examines individual countries in Group A, there is considerable variability with regard to both magnitude of change over time in the sex differential, and primacy of contribution of cause components. To illustrate, Australia shows the largest narrowing of the gap (-1.03 years in Table 1), with the contribution of heart disease being -.753 of a year (in Table 6). The gap in Iceland narrowed by almost one year (-.92), and the contribution of this disease was even more substantial, at -1.271 years, the largest of all nations. It may be important to reiterate the meaning of these figures: They indicate that if heart disease alone were to operate, net of the other causes of death, the sex gap in life expectancy would have narrowed by 1.271 years in Australia, and by .92 of a year in Iceland. In Belgium, where the change in the gender differenceis the smallest of all 16 nations in the Group (-.118), the effect of shifting sex differences in heart disease over the decade was -.294, which is larger than that associated with West Germany (-.23) and Austria (-.13).

In Austria, Denmark, Sweden, and West Germany, suicide shows negative contributions, indicating that while both male and female death rates went down over time, men in these societies have made larger improvements in risk. (Table of standardized death rates available on request). This situation differs considerably across the remaining nations in this Group, where the pattern of change in this component has favored women more, particularly in New Zealand (.248), Iceland (.200), Finland (.187), Australia (.133), Northern Ireland (.127) and Scotland (.121).

It is also interesting that in 14 out of the 16 countries in Group A, temporal change in sex differences in accidents/violence mortality contributed to a

narrowing of the sex gap, the largest effects having been in Australia (-.384), Austria (-.371), Canada (-.361), United States (-.311), Norway (-.298) and Northern Ireland (-.288). Thus, over the last decade, women's death rates from this cause category have been declining more slowly than those of their male counterparts. Only in Finland and New Zealand did this component serve to expand the survival discrepancy between the sexes, by .09 and .016 respectively. Another area where change in death rates seems to reflect some erosion in females advantage is cirrhosis of the liver---an ailment related to excessive alcohol consumption. In 10 out of the 16 countries the sign of this factor is negative, which contrasts sharply with the trend in the earlier decade, where only one nation showed a negative value (Iceland).

The influence of changing mortality rates due to prostate cancer and "other cancers" is fairly uniform across all countries in Group A (and in all other countries). In all cases, the effectof change in prostate cancer is to increase the disparity in life expectancy in favor of women. On the other hand, it is also true that breast cancer is a major killer of women across all nations, and its impact is always to narrow the differential.

With the exceptions of Austria, Northern Ireland, West Germany, and Belgium, changing sex differencesin lung cancer mortality during the 1980s have led to reductions in the magnitude of the female advantage in life expectancy, with Netherlands (-.259), Finland (-.255), Denmark (-.239), and England (-.175) leading the way. In these societies female mortality has been rising faster than that of males for at least two decades, especially between 1980 and 1990. Perhaps, this trend reflects the effects of the female smoking epidemic that began after the second World War, and accelerated over the ensuing decades. It appears, that for men, mortality due to lung cancer since the early 1980s has been increasing at a slower pace than is the case for females (Rennie and Rusting, 1996; Lopez, 1995; Lopez, Caselli and Valkonen, 2995; Waldron, 1993).

Only in five countries --- Finland, Netherlands, Norway, Sweden, England --- did the effect of "other circulatory" cause the sex gap in survival to expand over the 1980s, Sweden being the most conspicuous case representing this situation (.116). Belgium on the other hand, is exceptional in showing the largest narrowing due to this cause category (-.112). Concerning heart disease, its contribution is negative across all 16 nations, and its effects are quite substantial: Iceland shows the most pronounced reduction (-1.271); fairly large negative contributions are also noted for Australia (-.753), Canada (-.733), Finland (-.653), United States (-.679) and Sweden (-.602).

Thus, as a general summary of the pattern of cause contributions to narrowing sex gaps in life expectancy among Group A nations between 1980 and 1990, shifts in sex differences in heart disease were the primary force, followed in order of importance, by breast cancer, accidents/violence, other circulatory, and lung cancer. Had each of these causes operated alone (net of the effectsof the other

components) there would have been a substantially greater constriction of the sex gap than that actually observed. What dampened the combined negative impacts of these components were the counteracting influences of other cancers, prostate cancer, and to a lesser extent, residual causes of death.

Generally, the primacy of cause components in Group B, as shown in Table 5, is similar to that established by nations comprising Group A: heart disease, accidents/violence, lung cancer, breast cancer, prostate cancer, and other cancers, in that order. Moreover, as indicated in Table 6, between 1980 and 1990, societies in Group B were following closely the mortality trajectory of those in the preceding Group, as they seem very close to entering a stage of narrowing sex differences in life expectancy.

The corresponding averages at the bottom of Table 6 confirm that heart disease, other circulatory, breast cancer, and accidents/violence, all contributed negatively to the gender based differential over the last decade. However, once all ten causes are taken into account, the net result was a continuation of divergence, but at a reduced level as compared to the 1970s (refer to Table 3). Larger increases in male death rates as compared to females in the most recent decade from cancer of the lung, other cancers plus prostate cancer, and to a lesser extent residual causes, have played some role in maintaining a small diverging trend in the sex gap in survival. What is different in this group of nations (as compared to the previous two) is that contributions of heart disease, other circulatory, and accidents/violence are substantially weaker and therefore their combined negative influences were insufficient to override the divergent effects of the aforementioned causes.

In Group B there is considerable variance in the pattern of cause contribution across individual nations. For example, Italy has the lowest change in the sex gap in overall survival (.079), and the net contribution of heart disease would lower the difference by -.131; on the other hand Malta shows a contribution from this component of -.358, though in relation to Italy it has experienced a greater degree of expansion in its life expectancy differential(.123). Switzerland saw a widening of .265 of a year, but the negative effect of heart disease is marginal, at -.034. In Yugoslavia, the shift in the sex gap is the largest of all countries in this Group (.39), and the contribution of heart disease served to increase the sex difference by .246 of a year, all things equal.

Five out of the seven nations in Group B have undergone negative effects of other circulatory disease, particularly Malta, where the impact is substantial (-.52). In the case of lung cancer, with the exception of Switzerland, these societies all show positive contributions. These nations share some important similarities with those in Group A in regard to the pattern and direction of effects of cancer of the prostate and breast, other cancers, cirrhosis of the liver, accidents/violence, suicide, and residual causes. Thus, it seems clear that these nations are following the mortality trajectory of Group A, and it is only a matter

of time before they too embark on the same pattern of change in their sex differentials in life expectation.

Thus, the main reasons why Group B nations have not yet experienced a narrowing of their sex gaps are attributed to the overriding expansionary effects on the survival difference of lung cancer, prostate cancer, "other" cancers, suicide and residual causes. Were it not for the increasing functions over time of these components, the interplay of heart disease, other circulatory, breast cancer, liver cirrhosis, and accidents/violence, would have produced an overall narrowing of the life expectancy gap.

The situation for the seven nations in Group C (see the bottom of Table 5) indicates that in 1990, heart disease, residual causes, accidents/violence, other cancers, and lung cancer in that order, were the leading components. Heart disease alone accounted for one-fifth of the difference (25.10 %); and in combination, these five causes explained 84 per cent of the gender differencein life expectancy. In comparison to the previous two sets of nations, countries in this Group showed in 1990 larger positive impacts of other circulatory diseases, cirrhosis of the liver, and accidents/violence. Also important is the fact that heart disease contributions tend to be uniformly positive (except in Spain, where its effect is small and negative (-.078)).

The expansion of the magnitude of the differential in these societies between 1980 and 1990 can be explained to a large extent by the interplay of these same cause-of-death components. As shown in Table 6, only breast cancer contributed negatively (but by a small amount) across the nations in this group (-.041). Heart disease (.225), other cancers (.253), and lung cancer (.191) acted as the main agents to expand the female advantage in average length of life. Thus, a large part of the continuing divergence of the sex differentialin survival is a function of not only higher male mortality from the major killers, but also of more rapid increases over time in male death rates from these ailments.

In these seven countries there is considerable variability in direction and size of cause contributions to the change in the sex differencein expectation of life, which may not be surprising given their diverse social and economic structures. As seen in Table 6, the change in the sex gap between 1980 and 1990 ranges from a low of .566 of a year in Czechoslovakia, to almost one-and-a half years in Hungary. With regard to differencesin cause contributions, Spain shows a negative effect of heart disease, while the other countries all have positive values. Spain and Japan deviate from the general pattern of other circulatory diseases, in that they exhibit negative contributions. A similar tendency is also evident in the cases of liver cirrhosis, accidents/violence, suicide, and residual causes.

An important similarity these nations share with those in the Groups A and B is that temporal changes in breast cancer mortality uniformly act to reduce the female advantage in overall survival. As in the other societies, the trend in the

risk of breast cancer for females in these nations is also on the rise. The same prediction seems appropriate in the case of prostate cancer for men.

Concerning the contribution of liver cirrhosis, an almost equal number of nations in Group C have negative and positive effects. In Japan, Spain and Greece the change in this disease over the last decade seems to have favored men more than women, thus accounting for a narrowing effect. In Poland and Japan men have also shown larger improvements in their risk of death from accidents/violence. Some improvements in male suicide is also noted for Czechoslovakia and Japan.

Group C nations present an unusual pattern of cause contributions. Between 1980 and 1990, the leading components responsible for the changing sex difference in survival tend to differ from country to country. While heart disease has been the prime factor in Czechoslovakia, Greece, and Bulgaria, it is less important in Poland (third in rank of importance), Japan (fourth in rank), and Hungary (sixth in rank). In Czechoslovakia the four leading causes, in order of importance are heart disease, other cancers, lung cancer, and cirrhosis of the liver. In Greece, heart disease is the leading determinant, followed by lung cancer, other cancers, and accidents/violence. Other cancers have contributed the most to the Japanese differential, surpassing the contributions of residual, lung cancer, and heart disease. In Spain, other cancers, lung cancer and "residual" are virtually tied for primacy, followed by accidents/violence. Heart disease, other circulatory, other cancers, and lung cancer are the four leading cause-of-death components in Bulgaria. Perhaps of all seven nations in this Group, the pattern of cause contribution in Poland and Hungary are the most unusual. In the former nations, suicide is the predominant agent, followed by other circulatory, heart disease, and lung cancer. In Hungary it is cirrhosis of the liver and other cancers which have led in importance, followed by lung cancer, accidents/violence, other circulatory, and then heart disease.

Discussion

Over the last two decades, societies situated in North and Western Europe, and in the overseas Anglo-Saxon countries of Australia, Canada, New Zealand and United States, have witnessed a sustained slowdown in the pace at which the sex gap in life expectancy expanded, followed thereafter by a narrowing of this difference. Our analysis indicates that this phenomenon can be attributed to two important trends: (1) the tendency for men to make larger improvements in mortality, as compared to women, from certain cause categories, particularly heart disease and lung cancer, and also accidents and violence excluding suicide; (2) erosion of female survival probabilities associated with breast cancer, and lung cancer, in addition to slowdowns in the pace of improvements in mortality due to accidents and violence (excluding suicide).

We found that the largest contributor to narrowing the sex gap in overall survival was temporal changes in sex differences in heart disease mortality, followed by accidents/violence(excluding suicide) and residual causes of death (which includes many heterogeneous causes, including infectious diseases). The rising incidence of breast cancer among women seems to be a common feature of all industrial nations, but it is more pronounced in those societies where the sex gap in life expectancy has either narrowed or reduced. The same trend is evident in the case of prostate cancer among men. These two causes tend to counteract, but ultimately, breast cancer has a stronger impact, such that the net effect of these two components serves to reduce the overall survival advantage for women.

A second group of countries, located in Western and Southern Europe, including Portugal, Malta, Italy, France, Republic of Ireland, Switzerland, and the former Yugoslavia, appear to be following closely the path established by the preceding nations. They too demonstrate predominant effects of heart disease and accidents/violence, suicide, cancers of the lung and prostate, as well as "other cancers," in maintaining women's overall survival advantage. Though the temporal change in the sex gap continues to be positive in these countries, it has been getting smaller. It would appear that these societies are on the verge of entering a phase of narrowing sex differences in life expectancy.

We observed a third, heterogeneous category of countries, comprised of Japan, Greece, Spain, Czechoslovakia, Poland, Bulgaria and Hungary, where the differencein life expectancy in infancy continues to expand and/or is relatively large. In these societies, the temporal trajectory of change in the differentialhas been following the typical historical pattern of more rapid expectancy gains for females, accompanied in some cases by an erosion of male life expectancy (as in the cases of Hungary and Bulgaria; and for Poland between 1980 and 1990). The cause components responsible for the continued divergence in survival in this third set of nations tend to vary in importance from country to country. Unlike societies in Groups A and B, where heart disease and accidents/violence took on dominant roles, in this Group heart disease was not uniformly the leading cause.

The literature on sex differences in mortality has provided little, if any indication for an eventual narrowing of gender based differencesin survival during the later phases of this century. Omran (1971), the originator of epidemiological transition theory, gave no mention of this phenomenon; nor did Kitagawa (1978) in her overview of the 1970s literature. More recent works by Olshansky and Ault (1986) and of Rogers and Hackenberg (1991), give some indication of such occurrence during the advanced stages of epidemiological evolution, however the focus of their attention was exclusively on the situation prevailing in the United States and not to the broader international context.

The unanticipated trend mapped out in this study for sixteen highly industrialized societies represents a break from that which prevailed over the last

seven or eight decades; and if the noted pattern continues into the future, analysts will need to revise accordingly the theory of epidemiological transition.[3]

This phenomenon may turn out to represent a common feature of societies in the fourth stage of epidemiological transition, which has been defined by Olshansky and Ault as the "era of delayed degenerative diseases." In this study we have shown that to a significant extent, the mechanisms responsible for a narrowing of one of the most entrenched differentials in human populations are grounded in shifting patterns of mortality risk between the sexes primarily with regard to heart disease, accidents and violence, lung cancer, and the rising incidence of breast cancer in women, which is generally more pronounced than the rise of prostate cancer in men.

In the present study we focused exclusively on decomposing overall life expectancy on the assumption that in the industrialized world of late twentieth century, the vast majority of mortality dynamics tend to be concentrated in adulthood, particularly in the advanced ages (Fries, 1980; Olshansky and Ault, 1986; Olshansky, Carnes and Cassell, 1990; Olshansky and Carnes, 1993; Coale, 1996; Manton, 1982; Manton, Stallard and Tolley, 1991; Kannisto et al., 1994).[4] However, because changes in sex differences in life expectancy at birth do not necessarily reflect equal contributions by all age categories, our decomposition analysis should be extended to include age groups into the decomposition of sex differences in life expectancy. Rogers and Hackenberg (1991) have argued that recent developments among the youth and young adults are becoming increasingly important in shaping the epidemiological profile of contemporary society. This raises the possibility that part of the phenomenon observed in this study can be attributed to mortality dynamics in youth and young adult segments of the population. It is also possible that for some nations changes in infant and early childhood mortality may have some bearing on the change in overall survival between the sexes. But, given their advanced stages of epidemiological transition for the countries studied, it is highly unlikely that these early age components would contribute significantly to any observed changes in the sex differential in life expectancy. This being the case, in future analysis, one would have to look at how life style changes in adult men and women may account for either narrowing or expanding gender gaps in survival, and how different age groups contribute to such tendencies over time.

Footnotes

1. See El-Badry (1969) and Langford and Storey (1993) for situations where male life expectancy at birth is higher than that of females. A comprehensive account of the historical pattern of this differential is found in Stolnitz (1957).

2. Waldron and Johnston (1976) had suggested some twenty years ago that a "reversal of the trend may develop in the future" (p. 23). In her most recent cross-national investigation of changing sex ratios of mortality between 1977 and 1988, Waldron (1993) presents some evidence in support of her earlier assertion with Johnston. Preston (1993) has indicated that demographers have been aware of this new development. However, systematic analyses of the kind developed in this study based on international comparisons are lacking.

3. In the Coale and Demeny (1983) Model Life Tables, under conditions of very high mortality the gender gap in life expectancy at age zero fluctuates around two years; and as the level of mortality reduces, the sex differentialin life expectation widens in the manner observed over the historical experience of industrialized nations. What is also interesting is that at the very highest levels of life expectancy in the Model Tables, the gender gap in survival narrows in the manner documented in this study. (But see Vallin (1983) for a dissenting view on this.)

4. This study differs from that of Trovato and Lalu (1996) in the following aspects: (1) the current analysis is based on three time periods, with more precise start and end points (i.e. the first point of observation is 1970, the second is 1980, and the third is 1990); in the earlier analysis, the observations were for time periods---sometimes three or more years before or after surrounding 1970 and 1990; (2) the present study examines causes of death contributions to the change is sex gap in life expectancy at age zero, while the previous research did not consider causes of death; (3) the current investigation is based on a more extensive breakdown of the mortality data (i.e. by age, sex, period and country); (4) the earlier study included a number of nations not included in the present analysis.

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