J.biosoc.Sci, (2008) **40**, 297–312, © 2007 Cambridge University Press
doi:10.1017/S0021932007002453 First published online 24 Oct 2007

DECREASE IN SEX DIFFERENCE IN PREMATURE MORTALITY DURING SYSTEM TRANSFORMATION IN POLAND

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Summary. In recent years, sex differences in mortality have followed diverse patterns of change in developed countries. As there is no analogous evidence from Poland, the aim of this study was to describe the pattern of change in excess male mortality among Polish inhabitants aged 35–64 during 1995–2002, when the major socioeconomic transformation occurred, and compare it with sex differences in mortality observed in the late 1980s. During the study period, excess male mortality decreased significantly, independently of age and educational level. The reduction in mortality was observed in both sexes, but its magnitude was greater in men. These changes resulted mainly from a reduction in mortality rates due to cardiovascular disease and lung cancer in males and a concomitant increase in mortality rates due to lung cancer and suicides in females. Although, in general, excess male mortality decreased, social gradients related to this phenomenon increased. Subjects (in particularly men) who had graduated from university benefited the most, their magnitude of reduction in mortality rates being the greatest. Changes in social environment during the transformation period in Poland are suggested as major determinants of these changes, but further studies are needed.

Introduction

There is substantial evidence on differences in mortality between men and women. In developed countries, across all age groups, mortality rates are higher in men than in women; this phenomenon is described as 'excess male mortality'. Coronary heart disease, lung cancer, accidents and other violence have been identified as the major contributors to higher male mortality (Levi *et al.*, 1992; Lowlor *et al.*, 2001; Preston & Wang, 2005), which, in turn, result mainly from sex differences in anatomy, physiology and behavioural patterns. It is commonly known that men smoke more frequently, which directly leads to higher mortality due to lung cancer and heart disease (Payne, 2001). On the other hand, greater exposure to occupational hazards and higher rates of heavy drinking lead to higher accident rates and other violence-related mortality in male subjects (Waldron, 1993).

It should be emphasized that the changes in the sex mortality gap followed different patterns in developed countries during the 20th century. In some countries the gap increased, whereas in others it decreased or remained constant (Gjonca *et al.*, 2005). During the last 30 years, in the USA, Great Britain and Sweden, sex differences in mortality rates gradually declined (Trovato & Lalu, 1996; Luy, 2003). The reduction in sex differences since the mid-1980s resulted mainly from the greater reduction in cardiovascular disease (CVD) mortality in men as compared with women (Gjonca *et al.*, 2005).

In Poland after the Second World War, excess male mortality was observed and this increased steadily (Maksymowicz-Ajchel, 1993), and was particularly marked in the mid-1980s (Tabeau, 1996). The commencement of socioeconomic transformation in Poland (the beginning of the 1990s) was accompanied by an increase in all-cause mortality and an increase in the concomitant gap in mortality rates between Polish men and women (Tabeau, 1996). As a result, in Poland during this period, in contrast to developed countries, an augmentation in excess male mortality was observed.

In 1988–89, a research project on the sex difference in mortality was performed among inhabitants of four Polish cities, which documented a statistically significant male excess mortality across all age and social groups. It was demonstrated that excess male mortality increased in parallel to the deterioration of educational level (Rogucka, 1995).

In Poland, enormous socioeconomic changes occurred in the 1990s and at the beginning of the 21st century. The socialist nationalized economy was transformed into a free-market economy. The totalitarian one-party system was transformed into a multi-party parliamentary system. All these changes had numerous political, economic and social consequences (Szulc, 2000). For example, the workers in huge public factories lost their privileged position, and a new group of private entrepreneurs occupied an important position in the contemporary Polish economy (Keane & Prasad, 1999). Finally, modern Poland faced an entirely new phenomenon that had not existed before, namely unemployment (Kolodko & Rutkowski, 1991). In particular, women were affected by changes in the functioning of the labour market (Wróblewska, 2002). It is presumed that the recent socioeconomic transformation in Poland, accompanied by several changes in certain lifestyle elements, might have affected the biological status of Polish society, and these effects might have been distinct across the social strata (Moskalewicz & Świątkiewicz, 1998).

The present study was therefore carried out in order to describe the pattern of changes in excess male mortality in Poland during 1995–2002 when this major socioeconomic transformation occurred, and compare it with the sex difference in mortality observed in the late 1980s.

Methods

The study explores two surveys of the sex differences in premature mortality among adults carried out in 1995 and 2002 in Poland. The measure of mortality used in the analysis was the sex-, age-, education- and cause-specific rate of mortality (R) defined as a ratio:

$$R=(m/N)1000,$$

https://doi.org/10.1017/S0021932007002453 Published online by Cambridge University Press

where the numerator m is the number of all persons belonging to the category defined by the specific combination of these three variables (sex, age and education) who had died during a given period; while the denominator, N, is the total number of all analogously characterized persons alive in that population at the mid-point of the applied period.

Individual death data for men and women aged 35–64 were obtained from the national mortality database of the Central Statistical Office (CSO). In Poland, every death is reported to the main national death register. Mortality databases are constructed by the CSO based on the 'Statistical certificate of death notation', which is the part of a death certificate completed by physicians. Data on age, sex, date of death, education, cause of death and other demographical characteristics of the deceased person are included in this certificate.

As the data on living Polish adults were available only from the National Population Census, which took place in Poland in 1995 (Population and Housing Micro-Census) and 2002 (National Population and Housing Census 2002), it was decided that all records of deaths between 1st January and 31st December 1995, and between 1st January and 31st December 2002 would be used. The Population and Housing Micro-Census was performed as a sample survey and included nearly 2,145,000 persons, which constituted a 5% sample of a whole Polish population. The micro-census was performed in accordance with the representative method; approximately 5% of households were randomly chosen from all localized ones within 15% of all census regions. Obtained results were generalized for 98 subpopulations (rural and municipal parts from 49 administrative regions). In order to achieve an acceptable representation of the studied sample, a two-step schedule of random selection was applied. The first-degree units were drawn according to Sunter's schedule (as one of numerous schedules of drawing with different probabilities without returning to a common pool), whereas the second-degree units were drawn according to a simple schedule without returning to a common pool. Such procedures enabled balanced samples selected from all 98 subpopulations to be achieved. The results of this census have been accepted to be nationally representative, and can be generalized to the whole Polish population (CSO, 1996, 1998; Bracha, 1996; Kordos *et al.*, 2002).

All-cause and specific mortality were analysed for consequently defined sex and educational groups. Educational level was measured as the highest level of education that had been completed by individuals and three categories applied: (1) high level of education, i.e. subjects who had graduated from universities or institutes (tertiary education); (2) medium level of education, i.e. general secondary schools, vocational secondary schools and post-secondary schools; (3) low level of education, i.e. primary or incomplete primary schools, lower secondary schools and basic vocational schools (2 or 3 years of schooling above primary level in a specific craft). The International Classification of Diseases, Ninth Revision (ICD-9) and ICD-10 were used for coding of causes of death in 1995 and 2002, respectively. Table 1 presents the corresponding categories of ICD-9 and ICD-10 for causes of death applied in further analyses.

Sex and educational differences were analysed in three age groups: 35–44, 45–54 and 55–64. To assess the relative differences between men and women, sex mortality ratios (SexMR) with 95% confidence interval (CI) were calculated using Poisson

Table 1. Classification of analysed causes of death in 1995 (according to ICD-9), and corresponding codes from ICD-10 applied for deaths in 2002

Causes of death	1995 (ICD-9)	2002 (ICD-10)
Cancer (all)	140–239	C00–D48
Lung cancer	162	C34
Cardiovascular diseases (CVD)	390–459	I00–I99
Ischaemic heart disease	410–414	I20–I25
Cerebrovascular disease	430–438	I60–I69
External causes	E800–E999	V01–V99, W00–W99, X00–X59, X85–X99
Transport accidents	E810–E825	V01–V99
Suicide	E950–E959	X60–X84

regression. Age was adjusted in 10-year intervals for regression analyses. To assess relative mortality differences between 1995 and 2002, mortality rate ratios (MRRs) with 95% CI were calculated using Poisson regression analysis. All analyses were performed for both sexes, the three age groups and the three educational levels, separately. The parameters of the Poisson regression models were expressed as MRRs, with the 1995 mortality rates being the reference. Mortality rate ratio has a straightforward percentage interpretation, e.g. a group with a ratio of 1·50 has a 50% higher mortality than the reference group (Clayton & Hills, 1993). The absolute differences in mortality were evaluated using age-, sex- and education-specific rates of mortality. The significance of time changes in mortality rates was evaluated using the test of differences between two uncorrelated proportions, namely the z test (Guilford, 1960).

Results

Table 2 shows the numbers of dead and living Polish males and females aged 35–64 in 1995 and 2002, together with mortality indices, separately for males and females, and sex mortality rate (SexMR). Male mortality in 1995 was more than 2·6-fold higher than female mortality, whereas in 2002 excess male mortality decreased by 2·3% (SexMR = 2·56). Between 1995 and 2002 there was a reduction in excess of deaths in men as compared with women in most age and educational categories (Table 3). The only exception was the group of subjects aged >55 with the low educational level, in whom excess male mortality increased slightly.

The social gradient in excess male mortality, seen in the late 1980s, was also present in 2002. Even after adjustment for age effect, the lower the educational level, the more marked the excess male mortality. In contrast, in 1995 the relationship between excess male mortality and educational attainment was J-shaped. Moreover, between 1995 and 2002, the social gradient observed in this phenomenon increased significantly. It was particularly marked among the oldest (aged 55–64), where the social gradient between high and low educational levels increased more than 4 times

Table 2. Mortality rates of Polish adults aged 35–64 in 1995 and 2002

	1995	2002
Males		
Number of deaths	77,747	66,376
Population at risk	6,980,814	7,123,547
Mortality rate/100,000	111·4	93·2
Females		
Number of deaths	31427	27374
Population at risk	7,393,818	7,511,081
Mortality rate/100,000	42·5	36·5
SexMR (95% CI)	**2·62** (2·59–2·65)	**2·56** (2·52–2·59)

SexMR, sex mortality ratio; CI, confidence interval.

(from 0·17 up to 0·80) and among those aged 35–44, where this difference increased more than 3 times (from 0·29 up to 0·98).

Changes in mortality rates between 1995 and 2002 by sex, age and education groups are shown in Table 4 and Fig. 1. During this time, mortality rates decreased in all age and sex groups, but for men premature mortality rates decreased to a greater extent (by 17%) as compared with women (14%) (Fig. 1). The younger and the better educated the individuals (both men and women), the greater the reduction in mortality rates. Men aged 35–44 who graduated from university demonstrated the greatest reduction in premature mortality (42%, $p \leq 0{\cdot}001$) (Fig. 1). Moreover, the older and the worse educated the men, the smaller the reduction in mortality rates during the study period. Analogous trends were seen also for women, but the pattern was not so regular as for men. The only exception was found in women aged 55 and over, where mortality rates decreased significantly among those with a medium or a low educational level.

Cause-specific mortality rates for males and females, separately, and cause-specific SexMRs (with 95% CI) for different age and education groups in 1995 and 2002, are shown in Tables 5–7. In both sexes, the lower the educational level, the higher the cause-specific mortality rates.

During the study period, mortality rates for lung cancer in females significantly increased. Only among the youngest females from the low and high educational groups did mortality rates due to lung cancer diminish. Among women aged 45–54 and 55–64 in the low educational group, mortality rates for lung cancer increased by 41% and 48%, respectively (Table 6).

During this time, mortality rates for lung cancer in males decreased significantly. The greatest reduction in mortality rates for lung cancer was seen in men from the high education group aged 45–54 and 55–64 (a decrease of 52% and 23%, respectively, Table 6). As a result, excess male mortality rates due to lung cancer decreased significantly.

For both sexes, cardiovascular diseases (CVD) mortality rates decreased, but changes were more favourable in men, especially those who were well-educated.

Table 3. Sex mortality ratios in different age and educational groups in Poland in 1995 and 2002

	Sex mortality ratio (95% CI)					
	1995			2002		
Age group	High ed. level	Medium ed. level	Low ed. level	High ed. level	Medium ed. level	Low ed. level
35–44						
Females (ref.)	1·0	1·0	1·0	1·0	1·0	1·0
Males	2·52 (2·15–2·95)	2·30 (2·15–2·45)	2·81 (2·70–2·92)	1·82 (1·52–2·17)	2·11 (1·95–2·28)	2·80 (2·66–2·94)
High/low education distance		0·29			0·98	
45–54						
Females (ref.)	1·0	1·0	1·0	1·0	1·0	1·0
Males	2·16 (1·94–2·41)	2·14 (2·03–2·25)	2·99 (2·91–3·09)	1·85 (1·67–2·04)	1·96 (1·88–2·05)	2·69 (2·62–2·77)
High/low education distance		0·83			0·86	
55–64						
Females (ref.)	1·0	1·0	1·0	1·0	1·0	1·0
Males	2·57 (2·35–2·83)	2·41 (2·31–2·51)	2·74 (2·68–2·79)	1·97 (1·81–2·15)	2·18 (2·09–2·27)	2·77 (2·71–2·84)
High/low education distance		0·17			0·80	

Table 4. Changes in relative mortality rates between 1995 and 2002 in different age, sex and educational groups in Poland

Age	Educational level	Sex	MRR	(95% CI)
35–44	High	Females	0·80	(0·66–0·96)
		Males	0·58	(0·50–0·66)
	Medium	Females	0·79	(0·74–0·86)
		Males	0·73	(0·68–0·78)
	Low	Females	0·80	(0·76–0·85)
		Males	0·79	(0·77–0·82)
45–54	High	Females	0·82	(0·73–0·93)
		Males	0·70	(0·65–0·77)
	Medium	Females	0·84	(0·80–0·88)
		Males	0·77	(0·73–0·80)
	Low	Females	0·99	(0·96–1·03)
		Males	0·89	(0·88–0·91)
55–64	High	Females	0·99	(0·89–1·10)
		Males	0·76	(0·71–0·81)
	Medium	Females	0·93	(0·89–0·97)
		Males	0·84	(0·81–0·87)
	Low	Females	0·92	(0·89–0·94)
		Males	0·93	(0·92–0·95)
All ages	All educational levels	Females	0·86	(0·84–0·87)
		Males	0·83	(0·83–0·84)

MRR (mortality rate ratio) is the ratio of the mortality rates in 2002 to 1995, with the mortality rate in 1995 as the reference group; CI, confidence interval.

During the study period, the sex difference in CVD mortality rates showed mixed trends. For example, for the youngest group, the sex difference decreased in the high and low educated groups (from 5·78 to 4·42, and from 3·12 to 2·91, respectively), whereas among those with a medium education level, the sex difference increased (Table 5).

During the study period, in females mortality rates for cerebrovascular disease (such as cerebral ischaemia (I64), subarachnoid haemorrhage (I60), cerebral haemorrhage (I61) and cerebral infarcts (I63)) increased. This unfavourable change was seen in women aged 35–44 with low education level and in almost all educational groups of women aged 45 and over. The only exception was observed in women aged 45–54 with a medium educational level, as in this particular group mortality rates for cerebrovascular disease diminished by more than 4%. The greatest increase in mortality rate was demonstrated for women aged 45–54 who had graduated from university. In males, during the study period, mortality rates for cerebrovascular disease increased only in the oldest age group in those with a medium or high educational level (by 16% and 17%, respectively, Table 7).

Between 1995 and 2002, men developed an increase in mortality rates due to suicides, which was particularly high among those aged 45 and over with a high

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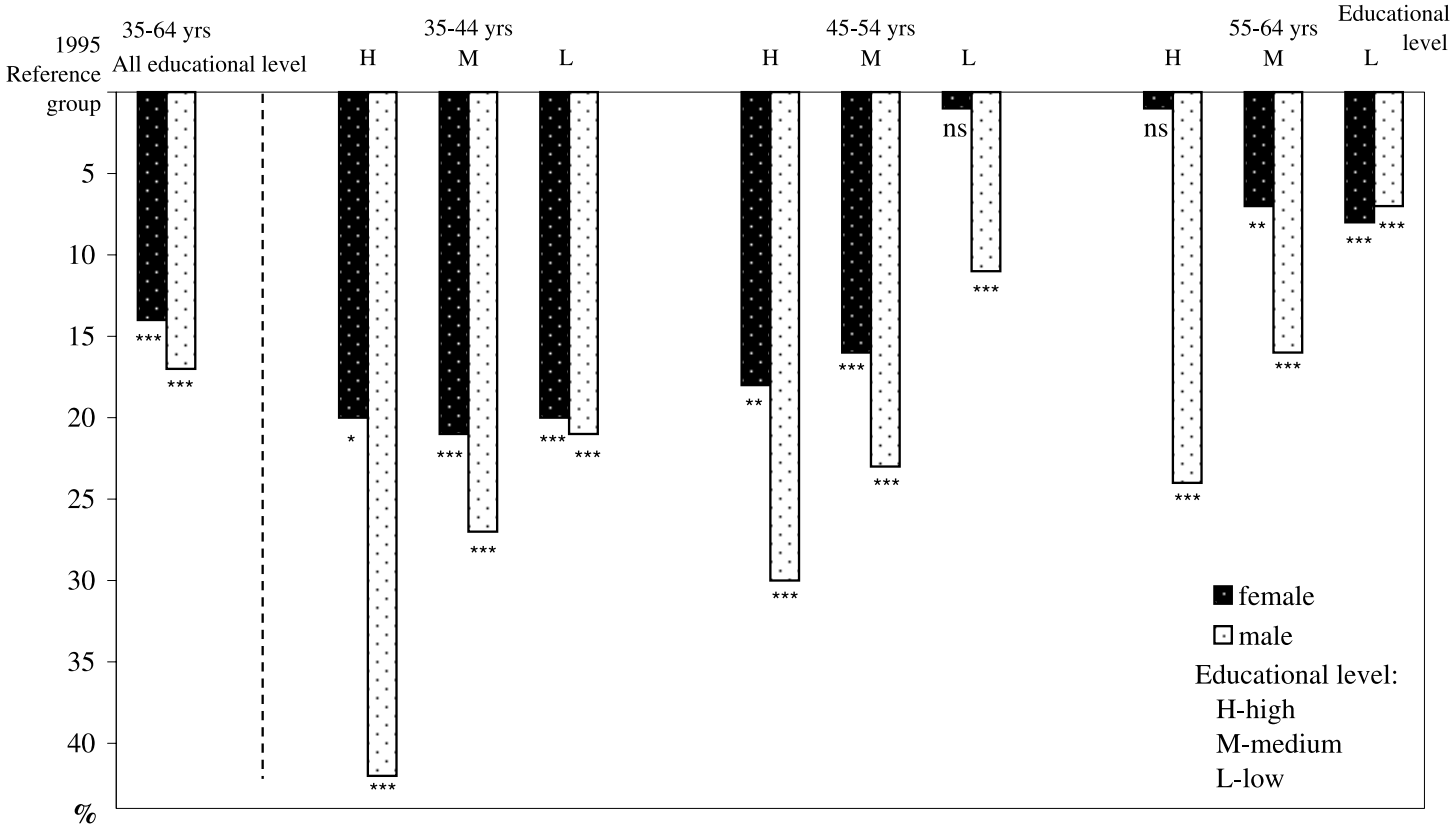

Fig. 1. Decrease (%) in mortality rates between 1995 and 2002 in different age, sex and educational groups in Poland. Differences significant at: *$p \leq 0{\cdot}05$, **$p \leq 0{\cdot}01$, ***$p \leq 0{\cdot}001$; ns, not significant.

Table 5. Age-standardized mortality rates per 100,000 and sex mortality ratios (SexMR) for selected causes of death in different educational groups in Polish men and women aged 35–44 in 1995 and 2002

Causes of death	High level of education							Medium level of education							Low level of education						
	Mortality rate			SexMR (95% CI)				Mortality rate			SexMR (95% CI)				Mortality rate			SexMR (95% CI)			
	1995	2002	Change	1995		2002		1995	2002	Change	1995		2002		1995	2002	Change	1995		2002	
Cancer (all)																					
Females	36·69	27·40	− 9·29	1·0		1·0		53·57	45·51	− 8·06	1·0		1·0		77·73	65·47	− 12·26	1·0		1·0	
Males	35·09	21·16	− 13·93	0·96	0·73–1·26	0·77	0·56–1·07	43·75	35·18	− 8·57	0·82	0·72–0·93	0·77	0·67–0·89	67·49	57·93	− 9·56	0·87	0·80–0·94	0·89	0·80–0·98
Lung cancer																					
Females	3·19	1·02	− 2·17	1·0		1·0		3·65	4·04	+0·39	1·0		1·0		7·08	6·90	− 0·18	1·0		1·0	
Males	4·13	2·78	− 1·35	1·29	0·51–3·34	2·71	0·73–12·30	9·67	4·97	− 4·70	2·65	1·83–3·87	1·23	0·79–1·91	18·55	14·23	− 4·32	2·62	2·10–3·29	2·06	1·58–2·72
CVD																					
Females	7·98	5·89	− 2·09	1·0		1·0		21·15	14·72	− 6·43	1·0		1·0		46·87	34·30	− 12·57	1·0		1·0	
Males	46·10	26·02	− 20·08	5·78	3·75–9·25	4·42	2·74–7·39	67·20	47·07	− 20·13	3·18	2·75–3·68	3·20	2·67–3·84	146·02	99·79	− 46·23	3·12	2·87–3·39	2·91	2·60–3·27
Ischaemic heart disease																					
Females	1·28	1·02	− 0·26	1·0		1·0		4·87	2·78	− 2·09	1·0		1·0		12·88	6·80	− 6·08	1·0		1·0	
Males	20·30	12·14	− 8·16	15·90	5·89–60·30	11·86	4·24–45·92	33·60	19·65	− 13·95	6·90	5·24–9·20	7·08	4·84–10·63	67·59	38·94	− 28·65	5·25	4·51–6·15	5·72	4·49–7·39
Cerebrovascular disease																					
Females	3·51	2·56	− 0·95	1·0		1·0		8·37	6·81	− 1·56	1·0		1·0		13·01	13·06	+0·05	1·0		1·0	
Males	10·67	3·47	− 7·20	3·04	1·49–6·70	1·36	0·51–3·63	11·24	10·19	− 1·05	1·34	1·01–1·79	1·50	1·09–2·06	21·19	17·53	− 3·66	1·63	1·37–1·94	1·34	1·09–1·66
External																					
Females	14·36	10·50	− 3·86	1·0		1·0		14·38	11·53	− 2·85	1·0		1·0		26·64	20·78	− 5·86	1·0		1·0	
Males	45·41	25·33	− 20·08	3·16	2·24–4·54	2·41	1·62–3·63	71·55	45·25	− 26·30	4·98	4·22–5·89	3·93	3·22–4·81	160·69	120·56	− 40·13	6·03	5·43–6·72	5·80	5·05–6·69
Traffic																					
Females	8·61	5·63	− 2·98	1·0		1·0		5·40	4·96	− 0·44	1·0		1·0		6·47	6·71	+0·24	1·0		1·0	
Males	20·99	12·84	− 8·15	2·44	1·53–3·99	2·28	1·31–4·06	26·95	17·83	− 9·12	4·99	3·80–6·61	3·59	2·64–4·95	45·01	39·64	− 5·37	6·96	5·63–8·69	5·91	4·63–7·63
Suicide																					
Females	3·51	3·84	+0·33	1·0		1·0		5·63	5·22	− 0·41	1·0		1·0		10·08	8·37	− 1·71	1·0		1·0	
Males	9·98	8·67	− 1·31	2·84	1·38–6·31	2·26	1·15–4·61	19·70	18·44	− 1·26	3·50	2·64–4·67	3·54	2·61–4·83	51·97	53·67	+1·70	5·16	4·34–6·17	6·41	5·16–8·05

Table 6. Age-standardized mortality rates per 100,000 and sex mortality ratios (SexMR) for selected causes of death in different educational groups in Polish men and women aged 45–54 in 1995 and 2002

Causes of death	High level of education							Medium level of education							Low level of education						
	Mortality rate			SexMR (95% CI)				Mortality rate			SexMR (95% CI)				Mortality rate			SexMR (95% CI)			
	1995	2002	Change	1995		2002		1995	2002	Change	1995		2002		1995	2002	Change	1995		2002	
Cancer (all)																					
Females	122·17	112·25	− 9·92	1·0		1·0		176·02	152·39	− 23·63	1·0		1·0		180·56	200·27	+9·71	1·0		1·0	
Males	144·77	93·56	− 51·21	1·19	1·01–1·40	0·83	0·71–0·97	176·28	149·88	− 26·40	1·00	0·92–1·09	0·98	0·92–1·06	296·40	292·01	− 4·39	1·64	1·56–1·73	1·46	1·39–1·53
Lung cancer																					
Females	12·50	13·71	+1·21	1·0		1·0		18·60	21·84	+3·24	1·0		1·0		23·91	33·77	+9·86	1·0		1·0	
Males	39·76	19·22	− 20·54	3·18	2·05–5·09	1·40	0·95–2·09	52·84	47·73	− 5·11	2·84	2·29–3·54	2·19	1·87–2·56	109·44	103·29	− 6·15	4·58	4·04–5·20	3·06	2·76–3·39
CVD																					
Females	43·96	29·13	− 14·83	1·0		1·0		80·35	57·91	− 22·44	1·0		1·0		131·39	106·27	− 25·12	1·0		1·0	
Males	176·75	116·56	− 60·19	4·02	3·21–5·08	4·00	3·21–5·03	268·35	181·58	− 86·77	3·34	3·02–3·69	3·14	2·87–3·43	434·05	347·46	− 86·59	3·03	3·13–3·49	3·27	3·09–3·46
Ischaemic heart disease																					
Females	12·96	4·86	− 8·10	1·0		1·0		21·15	16·80	− 4·35	1·0		1·0		39·30	30·08	− 9·22	1·0		1·0	
Males	93·78	52·29	− 41·49	7·24	4·87–11·15	10·77	6·53–18·93	138·51	86·11	− 52·40	6·55	5·48–7·87	5·13	4·39–6·01	197·79	158·51	− 39·28	5·03	4·57–5·55	5·27	4·76–5·85
Cerebrovascular disease																					
Females	12·03	15·42	+3·39	1·0		1·0		22·57	21·60	− 0·97	1·0		1·0		34·64	37·88	+3·24	1·0		1·0	
Males	31·12	29·93	− 1·19	2·59	1·63–4·22	1·94	1·38–2·76	38·60	33·77	− 4·83	1·71	1·38–2·13	1·56	1·32–1·86	66·01	63·37	-2·64	1·91	1·70–2·14	1·67	1·51–1·86
External																					
Females	12·50	8·57	− 3·93	1·0		1·0		20·16	15·12	− 5·04	1·0		1·0		25·81	25·75	− 0·06	1·0		1·0	
Males	56·18	37·49	− 18·69	4·50	2·95–7·08	4·38	2·91–6·77	81·33	59·88	− 21·45	4·04	3·32–4·92	3·96	3·34–4·71	186·51	146·55	− 39·96	7·23	5·97–8·14	5·69	5·10–6·37
Traffic																					
Females	5·09	4·00	− 1·09	1·0		1·0		7·38	4·72	− 2·66	1·0		1·0		7·02	7·80	+0·78	1·0		1·0	
Males	23·77	16·38	− 7·39	4·67	2·42–9·89	4·10	2·24–8·00	26·63	20·04	− 6·59	3·61	2·60–5·08	4·25	3·14–5·82	46·26	42·11	− 4·15	6·59	5·27–8·32	5·40	4·41–6·66
Suicide																					
Females	6·02	4·57	− 1·45	1·0		1·0		5·39	7·68	+2·29	1·0		1·0		9·47	11·78	+2·31	1·0		1·0	
Males	11·24	16·38	+5·14	1·87	0·93–3·96	3·58	2·01–6·73	23·53	26·23	+2·70	4·36	3·00–6·48	3·42	2·67–4·39	57·62	60·83	+3·21	6·08	5·01–7·44	5·17	4·38–6·12

Table 7. Age-standardized mortality rates per 100,000 and sex mortality ratios (SexMR) for selected causes of death in different educational groups in Polish men and women aged 55–64 in 1995 and 2002

Causes of death	High level of education							Medium level of education							Low level of education						
	Mortality rate			SexMR (95% CI)				Mortality rate			SexMR (95% CI)				Mortality rate			SexMR (95% CI)			
	1995	2002	Change	1995		2002		1995	2002	Change	1995		2002		1995	2002	Change	1995		2002	
Cancer (all)																					
Females	233·00	256·88	+23·88	1·0		1·0		305·17	338·81	+33·64	1·0		1·0		335·61	377·03	+41·42	1·0		1·0	
Males	377·03	336·45	−40·58	1·62	1·41–1·86	1·31	1·16–1·48	546·60	528·39	−18·21	1·79	1·68–1·92	1·56	1·46–1·66	823·84	853·21	+29·37	2·46	2·37–2·54	2·26	2·18–2·35
Lung cancer																					
Females	33·39	40·68	+7·29	1·0		1·0		39·70	56·56	+16·86	1·0		1·0		38·18	56·37	+18·19	1·0		1·0	
Males	120·01	92·10	−27·91	3·59	2·59–5·09	2·26	1·71–3·02	192·22	172·90	−19·32	4·84	4·13–5·70	3·06	2·67–3·51	351·73	339·74	−11·99	9·21	8·44–10·06	6·03	5·53–6·58
CVD																					
Females	124·47	93·06	−31·41	1·0		1·0		233·99	165·96	−68·03	1·0		1·0		395·41	292·39	−103·02	1·0		1·0	
Males	524·78	319·42	−205·36	4·22	3·57–5·01	3·43	2·89–4·10	723·37	530·22	−193·15	3·09	2·88–3·32	3·20	2·96–3·46	1094·54	903·45	−191·09	2·77	2·69–2·85	3·09	2·97–3·22
Ischaemic heart disease																					
Females	37·19	30·65	−6·54	1·0		1·0		76·39	51·61	−24·78	1·0		1·0		115·74	94·74	−21·00	1·0		1·0	
Males	256·45	170·36	−86·09	6·90	5·13–9·46	5·56	4·17–7·54	330·39	256·20	−74·19	4·33	3·85–4·87	4·96	4·35–5·68	425·72	383·75	−41·97	3·68	3·48–3·89	4·05	3·78–4·34
Cerebrovascular disease																					
Females	31·88	33·43	+1·55	1·0		1·0		51·73	51·96	+0·23	1·0		1·0		80·34	88·96	+8·62	1·0		1·0	
Males	74·16	48·44	−25·72	2·33	1·63–3·38	1·45	1·04–2·04	91·28	106·10	+14·82	1·77	1·50–2·09	2·04	1·75–2·38	163·18	191·12	+27·94	2·03	1·89–2·18	2·15	1·99–2·32
External																					
Females	17·46	19·50	+2·04	1·0		1·0		19·65	16·79	−2·86	1·0		1·0		27·43	24·42	−3·01	1·0		1·0	
Males	45·85	33·54	−12·31	2·63	1·64–4·38	1·72	1·12–2·68	68·12	58·42	−9·7	3·47	2·73–4·43	3·48	2·73–4·47	150·07	133·34	−16·73	5·47	4·91–6·11	5·46	4·78–6·25
Traffic																					
Females	4·55	10·03	+5·48	1·0		1·0		6·42	7·42	+1·00	1·0		1·0		10·27	8·54	−1·73	1·0		1·0	
Males	17·55	15·97	−1·58	3·85	1·58–11·30	1·59	0·86–3·03	20·96	17·29	−3·67	3·27	2·14–5·10	2·32	1·56–3·52	39·68	39·09	−0·59	3·86	3·22–4·66	4·58	3·64–5·80
Suicide																					
Females	6·07	5·01	−1·06	1·0		1·0		6·82	6·19	−0·63	1·0		1·0		7·70	9·73	+2·03	1·0		1·0	
Males	7·36	12·78	+5·42	1·21	0·47–3·37	2·55	1·14–6·23	13·79	18·60	+4·81	2·02	1·28–3·23	3·01	1·98–4·65	45·68	47·23	+1·55	5·93	4·84–7·32	4·85	3·92–6·05

educational level (by 46% and 73% in those aged 45–54 and 55–64, respectively). Only the youngest men with a medium or high education level demonstrated a reduction in mortality rates for suicides. During the study period, mortality rates for suicides increased also in women. The greatest increase in mortality rates for suicides was seen in women aged 45–54 with a medium or low education level (by 43% and 24%, respectively) and in those aged 55–64 with a low education level (by more than 26%). During the study period, changes in SexMRs for suicides in age and educational groups had no clear pattern.

During the study period, within several age and educational groups, sex difference in cause-specific deaths increased significantly. This was most marked in medium or low educational groups aged 35–44 and 55–64 (Tables 5 and 7). Among those with a high educational level, mortality rates increased only with regard to lung cancer (men aged 35–44), CVD (subjects aged 45–54) and suicides (subjects aged 45 and over).

Discussion

The major finding of this project is a demonstration that during the study period (being the second stage of socioeconomic transformation), excess male mortality decreased significantly in Poland, independently of age and educational level. A reduction in premature mortality was observed in both sexes, but its magnitude was greater in men. These changes resulted mainly from a reduction in mortality rates due to CVD and lung cancer in men and a concomitant increase in mortality rates due to lung cancer and suicides in women.

Although excess male mortality decreased in general, at the same time, social gradients related to this phenomenon increased. In other words, different social strata were affected by the socioeconomic transformation in a distinct way. Men who had graduated from university benefited the most. During the study period (1995–2002), the magnitude of reduction in mortality rates in these men, irrespective of their age, was greater than in any female subgroup.

It is presumed that sex differences in mortality rates are due to genetic and environmental factors (Waldron, 1985, 1993; Stindl, 2004). The relative importance of particular factors varies greatly, depending on socioeconomic and cultural backgrounds. It is suggested that in industrial societies, the important causes of the higher mortality for men have originated in behavioural and lifestyle differences. Men's higher rates of cigarettes smoking have been a major cause of their higher lung cancer and CVD mortality (Waldron, 1986; Doll *et al.*, 1994). There is evidence indicating that the sex difference in coronary heart disease mortality rates is secondary to inherent biological features, such as the protective effects of oestrogens in women and the harmful effects of male abdominal obesity (Wingard, 1990). In addition, men's heavier alcohol consumption and subsequent hazardous behaviour contribute to their higher mortality for alcohol-attributable diseases and accidents (Wilsnack *et al.*, 2000). In most post-socialist countries alcohol has been considered one of the main factors behind the increasing men mortality during early 1990s (Leinsalu, 1995; Leon *et al.*, 1997; Leinsalu *et al.* 2003). There is still a tendency for men to be more frequently employed in hazardous occupational environments than women (Waldron,

1985; Hemstrom, 1999; Doyal, 2000). The greater the exposure to hazardous work, the higher the mortality rates due to external causes.

The trend towards a lower sex difference in mortality rates, demonstrated in Sweden, Great Britain, Germany and France, was mainly a result of a rapid decrease in cardiovascular disease in men rather than in women (Waldron, 1993; Gjonca *et al.*, 2005). Similar patterns have been confirmed in recent analyses. In Poland, between 1995 and 2002, there was a marked reduction in male mortality due to diseases of the circulatory system.

These findings must by viewed against the background of the dramatic socio-economic changes that occurred in Poland during the analysed period, and whose essence was a transition from a centrally planned command economy, introduced in the late 1940s, to a free-market system. During this time, there was a rapid increase in the availability, variety and quality of consumer goods on the market, including food and other items. As a consequence, eating patterns were modified. Consumption of fresh fruit and vegetables, poultry, soft margarines and cooking oil increased, while consumption of sugar, butter, red meat and animal fat decreased (Statistical Yearbooks, 1989–2003; Szponar, 2000). It is suggested that an increase in non-hydrogenated and soya bean oil consumption can be considered as a major factor in the reduced coronary heart disease mortality rates (Zatoński *et al.*, 1998; Zatoński & Willet, 2005).

Reduction in smoking rates is also a crucial factor (Zatoński *et al.*, 1998). In Poland, during 1984–1999, there was a reduction in male smokers and an increase in those men who had quitted smoking. Such trends were not so marked in women, and there was even an increase by more than 18% in female smokers in the lower educational groups (Łopuszańska *et al.*, 2004). This study confirmed that women, irrespectively of their social background, quit smoking less frequently than men. This phenomenon seems to be responsible for an increase in female mortality rates for lung cancer and a reduction in male mortality rates for this particular cause. Smoking-related diseases are presumed to be responsible for a crucial part of sex difference in mortality (Payne, 2001; Pampel, 2002; Bobak, 2003). Similar patterns were seen in other countries, such as in France, Great Britain, the USA, Hungary and the Czech Republic (Peto *et al.*, 1994; Kubik *et al.*, 1995; Weiss, 1997; Gjonca *et al.*, 2005).

In Poland, the annual *per capita* consumption of alcoholic beverages (in units of pure alcohol) fell from 10·0 l in 1990 to 6·9 l in 2002, primarily as a result of the declining consumption of vodka (Statistical Yearbooks, 1989–2003). It is well known that in most countries women drink less alcohol than men. In recent decades, the gap between the amount of alcohol drunk by men and women has been shrinking significantly (Neve *et al.*, 1996). Epidemiological research indicates that lifestyle factors are particularly significant determinants of sex differences in premature mortality, especially those identified as hazardous factors. Improvement in this area could result in a decline in excess male mortality.

During the socioeconomic transformation in Poland, another powerful factor, practically non-existing in the socialist economy, appeared on the scene, namely unemployment. Nationwide rates of unemployment rose from zero in 1989 to nearly 20% in 2002 (CSO 2002a, 2002b). Conditions of participation in the labour market have changed significantly, and have affected woman in particular. During the whole

transformation period, unemployment rates were on average 4% higher for women than men, particularly in lower educated groups (Statistical Yearbooks, 1989–2003). Women in Poland have had relatively few opportunities to find a new job and have longer periods of unemployment than men (Wróblewska, 2002). These factors could have affected female health, especially their mental status. Studies across nineteen countries in the transition region have shown that women more frequently suffered from depression and emotional difficulties than men. Depressive and post-traumatic stress disorders account for one-third of the total disabilities from mental health problems for women and only 10% for men (World Bank, 1993). Generally, women are more susceptible to growing competitive pressure and job insecurity. These elements could have modified female mortality rates due to CVD and suicides.

The observed increase in the social gradient regarding excess male mortality may be a result of the unequal benefits of the socioeconomic changes in Poland; better education is accompanied not only by a broader knowledge of health and healthy behaviour, but also determines life opportunities and position in the labour market. The more comfortable financial position, greater job security, better ability to adapt to new conditions and healthier lifestyle of more highly educated people has produced better health conditions for these groups, and in consequence lower levels of mortality.

In conclusion, between 1995 and 2002 in Poland premature mortality rates decreased in both sexes, but the sex difference in mortality rates increased. At the same time, social gradients related to this phenomenon increased. Changes in the social environment during the transformation period in Poland are suggested as major determinants of these changes.

Acknowledgment

This project was supported financially by a research grant from the Ministry of Science and Higher Education (Poland) No. 3PO4C 059 24.

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