Opposing National Stroke Mortality Trends in Poland and for African Americans and Whites in the United States, 1968 to 1994

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Background and Purpose—The United States (US) has experienced declines in stroke mortality in contrast to the increases reported for Poland. As part of the Poland and US Agreement on Cardiovascular and Cardiopulmonary Research, stroke mortality trends in Polish and US subpopulations were compared in the context of cross-population differences in competing causes of death and determinants of stroke.

Methods—Age-adjusted annual stroke, cardiovascular disease (CVD), non-CVD, and all-cause mortality rates were determined for men and women aged 35 to 64 and 65 to 74 years from 1968 to 1994 for African Americans and US whites and in Poland. Mean annual percent changes of mortality rates were estimated during 1968 to 1980 and 1981 to 1994 with the use of piecewise log-linear regression.

Results—US stroke mortality rates declined 3.7% to 4.8% annually during 1968 to 1980 and 2.0% to 3.1% during 1981 to 1994, with similar declines in each ethnic, gender, and age group. Polish rates increased 3.3% to 5.5% annually for all age-gender groups in Poland during 1968 to 1980. Polish men aged 35 to 64 experienced increasing rates during 1981 to 1994 (1.6% annually), while Polish women and older men experienced slight declines or little change. Only Polish men aged 35 to 64 years exhibited increases in stroke, CVD, and non-CVD mortality rates during both time intervals.

Conclusions—Poland and the US experienced opposing stroke mortality rate trends between 1968 and 1994. These national and ethnic trends occurring in just one generation suggest major effects of lifestyle, socioenvironmental, and/or medical care determinants. (Stroke. 1998;29:1366-1372.)

Key Words: cardiovascular diseases ■ cerebrovascular disorders ■ epidemiology ■ mortality

Trends for stroke and total CVD mortality have been strikingly different in Poland and other central or eastern European countries compared with the US.1–5 In general, stroke and CVD rates in Poland have been increasing contemporaneously with declines in the US. Although international variation in stroke and CVD mortality rates is not well understood, temporal and cross-population variations in lifestyle, socioenvironmental, and medical care determinants within countries and between countries may provide a partial explanation.6–13 Cross-population differences in genetic susceptibility to CVD and CVD risk factors have also been suggested.14–16

As part of the Poland and US Agreement on Cardiovascular and Cardiopulmonary Research between the Poland National Institute of Cardiology and the US National Heart, Lung, and Blood Institute,17 this report compares stroke mortality rates in the two countries from 1968 to 1994. Stroke mortality was selected because of its sensitivity to a number of modifiable risk factors,18 particularly hypertension,19,20 and because of its relation to social and demographic characteristics of communities and individuals.21–23 An important objective of this study was to contrast stroke mortality trends between the two countries across strata of gender, age, and ethnicity (US only) because the different stroke mortality rates experienced among these populations suggest that trends may also differ. We evaluate these contrasts in the context of competing causes of death and previous reports of cross-population variation in the determinants of stroke and CVD.

Subjects and Methods
Stroke, CVD, non-CVD, and all-cause mortality rates and trends in Poland and for African Americans and whites in the US from 1968 to 1994 were calculated for men and women aged 35 to 64 years and 65 to 74 years. Vital statistics for the US were stratified into African American and white subpopulations because of the markedly different stroke mortality experiences of these two groups.3 National mortality and population data were obtained from the Main Statistical Office in Poland24 and from the US National Center for Health Statistics Compressed Mortality File.25 Five-year age strata from the
Polish data were aggregated to match the 10-year age strata provided for the US. Direct age standardization was performed for subjects aged 35 to 64 years with weights determined previously from Segi’s world population.26

Underlying cause of death in Poland was classified in accordance with the seventh27 (1968 to 1969), eighth28 (1970 to 1979), and ninth29 (1980 to 1994) revisions of the International Classification of Diseases, Traumas, and Causes of Death. Underlying cause of death in the US was classified in accordance with the Eighth Revision International Classification of Diseases, Adapted for Use in the United States30 (1968 to 1978) and the ninth revision of the ICD31 (1979 to 1994). Deaths attributed to stroke were identified as seventh revision rubrics 330 through 334 (vascular lesions affecting the central nervous system) and eighth and ninth revision rubrics 430 through 438 (cerebrovascular disease). Deaths attributed to CVD were identified as seventh revision rubrics 330 through 334 and 400 through 468 and eighth and ninth revision rubrics 390 through 459. Deaths attributed to non-CVD causes included all rubrics other than those for CVD.

Mortality rate trends were evaluated with the use of piecewise log-linear regression techniques within strata of cause, country, age, gender, and ethnicity (US only) for the time periods 1968 through 1980 and 1981 through 1994. These time intervals were chosen to be contemporaneous with previously reported periods of accelerating and decelerating rates of decline in US stroke mortality rates3,32 and are not intended to represent best-fit curves. The log-linear model assumes constant proportional or relative change over time and has been used in previous studies of stroke mortality rate trends.22,32 Regression modeling was performed with the SAS REG procedure.11 Predicted mortality rates from regression models were used to calculate mean annual percent change in mortality rates during each time interval.

**Results**

Included in this study were approximately 300,000 deaths attributed to stroke in Poland, a similar number of stroke deaths for African Americans, and 1.3 million stroke deaths for US whites occurring from 1968 to 1994. These stroke deaths accounted for 6.6%, 8.5%, and 5.8% of all deaths occurring in populations aged 35 to 74 years in Poland, for African Americans, and for US whites, respectively, during this time interval. Annual mortality rates, expressed as deaths per 100,000 population, are illustrated in Figures 1 and 2. Consistent with previous reports, stroke mortality rates were higher for men than for women, for African Americans than for US whites, and for older persons than for younger persons in each country. Mortality rates in both figures are shown on a log scale to facilitate comparisons of relative trends among these populations with very different mortality experiences.

African American and US white men and women aged 35 to 64 years (Figure 1) experienced decreasing stroke mortality rates between 1968 and 1994. In contrast, stroke mortality rates increased in Poland from 1968 to 1980 for each gender in this age group. Stroke mortality rates continued to increase for Polish men during the late 1980s but peaked and declined slightly for Polish women. CVD mortality rates for men and women aged 35 to 64 years generally decreased for African Americans and US whites and increased in Poland. However, a striking decrease in CVD mortality rates of nearly 20% occurred for both men and women aged 35 to 64 years in Poland during the early 1990s. Non-CVD mortality rates for persons aged 35 to 64 years in each US ethnic-gender group declined somewhat during the 1970s and early 1980s and stabilized thereafter. In contrast, non-CVD rates in Poland generally increased for men and changed little for women. All-cause mortality rates from 1968 to 1994 for persons aged 35 to 64 years decreased for each US ethnic-gender group, increased for Polish men, and changed little for Polish women, except for a recent decrease in the early 1990s.

Stroke mortality rates for African-American and US white men and women aged 65 to 74 years (Figure 2) decreased between 1968 and 1994. Stroke rates for men and women of this age in Poland generally increased from 1968 to the late 1970s and fluctuated thereafter. CVD mortality rates for persons aged 65 to 74 years decreased in each US ethnic-gender group from 1968 to 1994. These rates in Poland generally increased during the 1970s and early 1980s and subsequently changed little for men and declined for women. Non-CVD mortality rates for persons aged 65 to 74 years changed little in the US for each ethnic-gender group except for increases in women during the 1980s and 1990s. In

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**Selected Abbreviations and Acronyms**

- CHD = coronary heart disease
- CVD = cardiovascular disease
- ICD = International Classification of Diseases
- MONICA = Monitoring of Trends and Determinants in Cardiovascular Disease
- US = United States

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Figure 1. Age-adjusted stroke, CVD, non-CVD, and all-cause mortality per 100,000 population for US whites, African Americans (US-AA), and in Poland from 1968 to 1994 for men and women, age of death 35 to 64 years (log scale).
Poland and US Stroke Mortality Trends

Figure 2. Stroke, CVD, non-CVD, and all-cause mortality per 100,000 population for US whites, African Americans (US-AA), and in Poland from 1968 to 1994 for men and women, age of death 65 to 74 years (log scale).

Discussion

These results illustrate a pattern of opposing national trends in stroke mortality rates between the US and Poland from 1968 to 1994. The period of accelerated decline in stroke mortality rates during the 1970s for African Americans and US whites was contemporaneous with a period of relatively rapid increases in Poland. Beginning in the early 1980s, US white and African American populations experienced continued but less rapid declines in stroke mortality rates, which may have culminated in a leveling of the decline in the 1990s. Similarly, stroke mortality rates in Poland began to stabilize during the 1980s for all populations studied except for Polish men aged 35 to 64 years, who experienced generally persistent increases in stroke mortality rates. Indeed, these Polish men experienced increases in CVD, non-CVD, and all-cause mortality rates concurrent with their relatively large increases in stroke mortality rates from 1968 to 1994. As a result, they have become increasing more likely to experience death due to CVD and non-CVD causes relative to women, leading to a widening mortality rate gap between genders in Poland.

Previous studies have suggested that temporal, geographic, and ethnic variation in the distribution of known risk factors may partially explain cross-population differences in stroke and CVD mortality rates.\(^{6-12}\) It is likely that differential exposures to risk factors and to effective preventive interventions in Polish and US populations may explain at least a portion of the observed disparities in stroke and CVD mortality rate levels and trends. Prominent among the recognized risk factors are hypertension, cigarette smoking, ethanol consumption, diabetes, physical inactivity, dietary fat intake, and hypercholesterolemia. Substantial differential exposures to risk factors have been demonstrated over time and between and within nations.\(^{9,12,34-38}\) Supportive of the explanatory role of avoidable risk factors and health behaviors is a study of Seventh Day Adventists living in Poland who were observed to experience much lower exposures to tobacco and ethanol while enjoying markedly higher life expectancies compared with the Polish population in general.\(^{39}\) In addition, the mortality rate gap between gender groups observed in the Polish population was not seen in the Seventh Day Adventists group.\(^{39}\)

An association of hypertension with stroke and with other manifestations of CVD has been well established.\(^{40}\) A previous report comparing data collected from the Polish MONICA Study from 1983 to 1984 with data from the US Lipid Research Clinics Program Prevalence Study from 1972 to 1976 revealed markedly higher systolic blood pressures (approximately 10 to 20 mm Hg higher) in Poland than in the US.\(^{17}\) A recent study of hypertension comparing MONICA participants with those from the US Atherosclerosis Risk in Communities (ARIC) cohort demonstrated that mean systolic blood pressure remained more than 15% higher for Polish samples than for the US in the late 1980s.\(^{41}\) The strikingly higher prevalence and poorer control of hypertension in Poland compared with the US were attributed to the success of US hypertension control programs.\(^{21}\) It has also
been shown that African Americans experience higher hypertension prevalence rates than US whites.42 On the basis of data from the US Third National Health and Nutrition Examination Survey (NHANES III, 1988 to 1991), the age-adjusted prevalence of hypertension (ie, systolic blood pressure ≥140 mm Hg, and/or diastolic blood pressure ≥90 mm Hg, and/or the use of antihypertensive medications) in non-Hispanic African Americans (32.4%) was almost 40% greater than that of non-Hispanic US whites (23.3%).43 Nevertheless, some studies have suggested that little of the accelerated decline was due to progress in the treatment and control of hypertension.47,48

Differences in cigarette smoking prevalence rates and consumption are consistent with the observed stroke and CVD mortality rate disparities and trends. Consumption of tobacco in Poland dramatically increased during the 1970s and early 1980s, then stabilized at a level that remains one of the highest in the world.49–51 Increasing tobacco consumption in Poland has been accompanied by predictable increases in cancer mortality rates, especially in men, no doubt exacerbating the upward non-CVD mortality rate trends noted previously for men aged 35 to 64 years.49 Reductions in upward stroke mortality trends in Poland during the 1980s and 1990s may have been partially due to the contemporaneous stabilization of tobacco consumption. Although the prevalence of cigarette smoking is lower for women than for men. In 1994, the prevalence of smoking in Polish women has been similar to

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AA indicates African American.
that of US women, but smoking prevalence for Polish men has been almost twice that of US men.\textsuperscript{34,38,51}

Trends in the consumption of ethanol and animal fat in Poland and in the US may have contributed to observed changes in stroke and CVD mortality rates. Per capita ethanol consumption doubled in Poland from 1962 to 1978, abruptly declined by approximately 50% in the early 1980s, and may have increased through the early 1990s.\textsuperscript{50,55} Perhaps more than coincidentally, Polish CVD mortality rates, previously increasing, showed marked declines in the early 1990s. It should be noted, however, that stroke mortality rates in Poland did not exhibit similar declines during the 1990s. Since CHD is the major contributor to CVD mortality rates, the downward trend of CVD mortality rates during the early 1990s was likely more heavily influenced by CHD rather than stroke mortality. This suggests a prominent role for CHD in the recent CVD mortality rate declines, and if reduction in animal fats was responsible, it appears that stroke mortality in Poland is not as strongly associated with animal fat consumption as is CHD mortality. Declines in the consumption of animal fats have been observed in the US contemporaneously with declines in serum cholesterol levels since at least the 1970s.\textsuperscript{12,35,57}

Diabetes mellitus and physical inactivity have been identified as important risk factors for stroke.\textsuperscript{38–42} It has been suggested that these two risk factors are associated with each other through pathways that may involve obesity.\textsuperscript{53,64} Results from the National Health Interview Survey in the US indicate that the age-adjusted prevalence of self-reported diagnosed diabetes increased 15% from 1980 to 1994.\textsuperscript{65} A high prevalence of self-reported overweight (21%) and sedentary lifestyle (58%) has been found in the US (1988) in the Behavioral Risk Factor Surveillance System.\textsuperscript{56} The paradoxical increase in the prevalence of obesity with contemporaneous declines in dietary fat intake in the US during the 1970s and 1980s has been attributed to declines in total physical activity energy expenditure.\textsuperscript{67} The prevalence of diabetes in African Americans is higher than in US whites, consistent with observed ethnic differences in stroke mortality.\textsuperscript{35,68} Increasing trends in diabetes, physical inactivity, and obesity may partially explain the decelerating rate of decline in stroke mortality in the US.

Low socioeconomic status of individuals and adverse community socioenvironmental conditions have been directly related to stroke and CVD and may partially explain mortality rate disparities between the US and Poland and between US ethnic groups.\textsuperscript{13,22,69–72} Important socioeconomic and political changes that have occurred in Poland have transformed its social structure and influenced patterns of disease.\textsuperscript{72–76} The US has experienced rapid socioeconomic development in its rural southeastern “Stroke Belt” region, which may have contributed to important declines in stroke mortality rates in that region and for the nation as a whole.\textsuperscript{77,78} Increasing inequalities in the distribution of income may have adversely influenced mortality rates in the US.\textsuperscript{70,79}

It is likely that observed mortality rate trends have been influenced by trends in diagnostic custom and recording practices. Studies of the accuracy of US stroke death certification compared with autopsy diagnoses and standardized diagnoses using medical records reveal positive predictive values for death certificate diagnoses ranging from approximately 80% to 100% and sensitivities in the range of 60% to 70%.\textsuperscript{80–84} One study found that the positive predictive value and sensitivity of stroke death certificate diagnoses improved from 1970 to 1980.\textsuperscript{85} A trend of improving sensitivity in the death certificate diagnosis of stroke could diminish the decline of stroke mortality rates. An evaluation of case ascertainment in the World Health Organization MONICA Stroke Study has revealed that death certificate diagnoses in Poland agreed with MONICA Stroke Register diagnoses in 64% of the stroke cases.\textsuperscript{86} In the presence of similarity of trends among stroke, CVD, and all-cause mortality rates as observed in each country, there is less likelihood of erroneous inferences due to trends in misclassification of cause of death. Because of the consistency of coding for stroke and CVD in the eighth and ninth revisions of the ICD, it was assumed that comparability across these revisions is reasonably good. The use of seventh revision rubrics was limited to Poland from 1968 to 1969. Therefore, no comparability adjustments were made to mortality rates across ICD revisions in this study. The abrupt mortality rate declines observed in the early 1980s in Poland appear to be contemporaneous with the implementation of the eighth revision of the ICD in that country. In general, however, the influence of ICD revisions on mortality rates appears to be minor, supportive of the relatively low impact of coding changes on the broad categories of cause of death used in this study.

In conclusion, stroke mortality rate trends in the US and in Poland from 1968 to 1994 have been opposing. However, a leveling of stroke mortality rates during the 1990s may be occurring in the US and for women and elderly men in Poland. Middle-aged Polish men have shown a distinctly different mortality rate trend pattern characterized by increasing stroke, CVD, and non-CVD mortality rates. This suggests that mortality rates for this group may be the result of fundamentally different susceptibilities and determinants compared with other groups in Poland or in the US. Indeed, this group may warrant intensified research and targeted public health interventions. The observed national, gender, and ethnic inequalities in stroke mortality are consistent with differential exposures to avoidable CVD risk factors, and, although more complex, socioeconomic and community socioenvironmental factors may also play an important role. These relative national and ethnic trends occurring in just one generation suggest major effects of lifestyle, socioenvironmental, and/or medical care determinants for cross-population differences in stroke mortality rates.
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References


50. Zatonski W. *Evolution of Health in Poland Since 1988.* Warsaw, Poland: Maria Sklodowska-Curie Cancer Centre and Institute of Oncology, Department of Epidemiology and Cancer Prevention; 1996.


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