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US Mortality in an International Context: Age Variations

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Compared to other developed countries, the United States ranks poorly in terms of life expectancy at older ages. In terms of life expectancy at age 50, it trails the world leader, Japan, by 3.3 years and the 29 countries ahead of the US by an average of 1.3 years (WHO 2009). A majority of the difference in life expectancy at birth between the US and other developed countries is attributable to differences in life expectancy above age 50.

The US's poor performance is often blamed on its health care system. In a previous analysis, we reviewed a number of studies comparing the efficacy of the US health care system with that of several other developed countries (Preston and Ho 2009). We found that, by the standards of other OECD countries, the US health care system typically functions well in the treatment of cancer and heart disease, the two leading causes of death at older ages. We examined in more depth death rates from prostate and breast cancer, diseases for which effective methods of identification and treatment have been developed and where behavioral factors do not play a dominant role. We found that the US experienced a significantly faster decline in prostate and breast cancer mortality than the comparison countries between 1994 and 2005. On the basis of this analysis we concluded that the health care system is not responsible for the US's low life expectancy ranking at age 50 (Ibid).

Only one broad age range, 50+, was considered in that analysis. We now supplement that analysis by considering the relative ranking of the US at different ages among a comparison set of 17 OECD countries. Research related to this topic is scarce. One exception is an article by Manton and Vaupel (1995), who documented that the US had unusually favorable survival after age 80 relative to Sweden, France, England, and Japan. Using extinct-cohort methods, they found that US life expectancy at age 80 significantly exceeded life expectancy in the comparison countries. They speculated that this phenomenon may reflect more effective medical care and more favorable personal behaviors among the elderly in the US compared to the elderly in Europe and Japan. They also noted the possibility of persistent cohort effects involving education, immigration, selection, and adverse health conditions at younger ages. In contrast, Nolte and McKee (2008) find that the US has unusually high death rates below age 75 from a number of diseases including heart disease and stroke. In this paper, we consider the international ranking of the US in greater detail by focusing on five-year age groups beginning at age 40, and attempt to shed light on the sources of the unusual age pattern that emerges.

Age Patterns of International Rankings

We use two primary measures to characterize the international variation in mortality rates by age in 2005: the ranking of US age-specific mortality rates among 18 OECD countries; and the ratio of US age-specific mortality rates to the unweighted mean of the other 17 OECD countries. The comparison countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, Portugal, and the United Kingdom. Calculations are done for males and females separately. Death rates by country, age group, and sex are taken from the Human Mortality Database (HMD) (2008) for the comparison countries. US death rates were calculated from the most recent US National Center for Health Statistics life tables that have not yet been issued (Arias 2009). They reflect an increase in mortality at ages above 85 relative to previously-issued life tables. This increase brings them into close alignment with life tables produced by the Social Security Administration.

Figure 1 shows that, between ages 40 and 75, US all-cause mortality rates are among the poorest in the set of comparison countries. The US position improves dramatically after age 70 for males and after age 75 for females. Lest it be thought that what happens above age 75 is relatively unimportant for measures of longevity, it should be pointed out that two-thirds of *newborns* (67.3%) survive to age 75 in the published US life tables for 2006 (National Center for Health Statistics 2009: 26).

Figure 1. Ranking of US Age-Specific Death Rates Among a Comparison Set of 18 OECD Countries in 2005

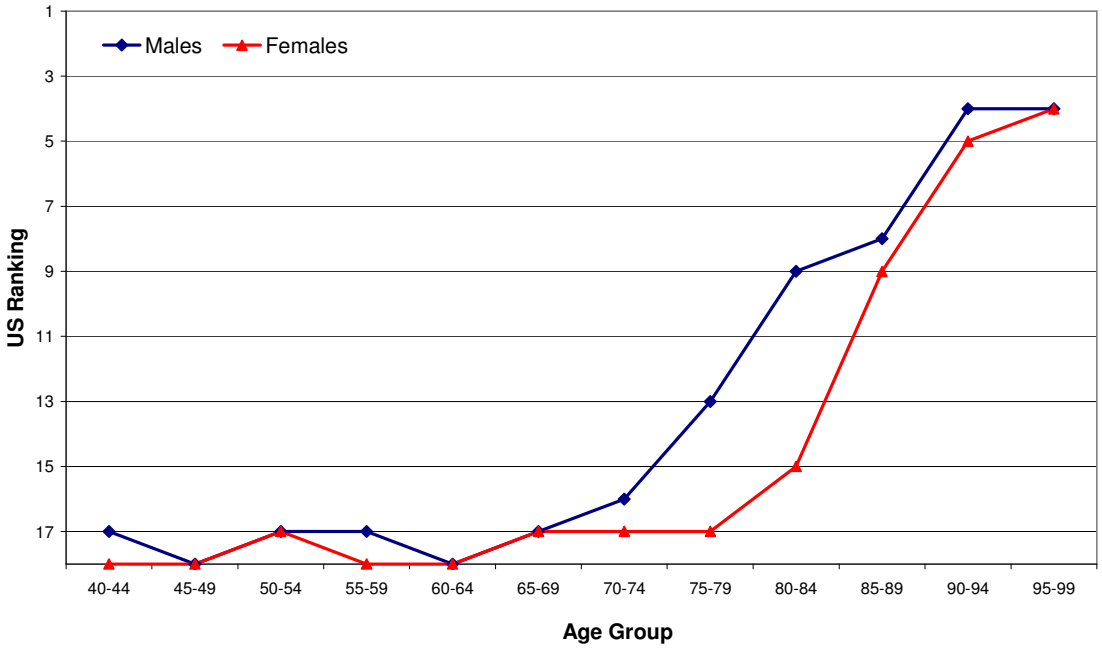
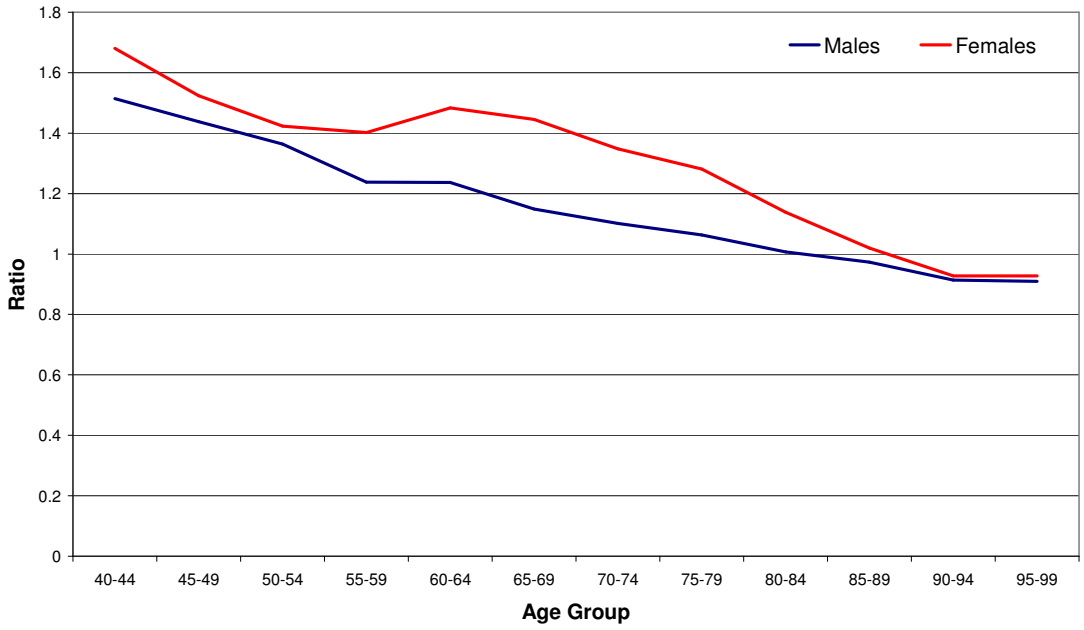


Figure 2. Ratio of US Age-Specific Death Rates to the Average of a Comparison Set of 17 OECD Countries in 2005



Males do better than females in every age group except 95-99. US males rank fourth out of eighteen countries in the age groups 90-94 and 95-99, while US females rank fifth and fourth in these age groups. The pattern shown in Figure 1 is echoed in Figure 2, where the ratio of US female age-specific death rates to the average of the comparison countries always lies above the male ratio. Clearly, we observe a very striking pattern of improvement in US rankings from near the bottom to near the top as age advances. This sharp upward slope in US mortality rankings with age has not previously been documented and is one of the most dramatic features of the US mortality profile.

The quality of US data for African Americans at old ages has been called into question because of extensive evidence of age misreporting, which has produced underestimates of mortality at ages above 85 (Preston et al 2003). We have recalculated rankings using data for whites alone. Figures 3 and 4 show the rankings and ratios when data on whites alone in the US are used. Results are similar to those for the total population, although males improve by several ranks at younger ages. The pattern of rapid improvement in US rankings by age is maintained.[1]

[1] We also perform a data quality check by computing the rankings and ratios using life table death rates from the Social Security Administration, which employs a different methodology than NCHS. The patterns were very similar for females and both sets of ratios. Between ages 80 and 99, the ranking of US male death rates does not improve as markedly as it does in the NCHS data set; otherwise, the same pattern of improvement is observed.

Figure 3. Ranking of US Age-Specific Death Rates (Whites Only) Among a Comparison Set of 18 OECD Countries in 2005

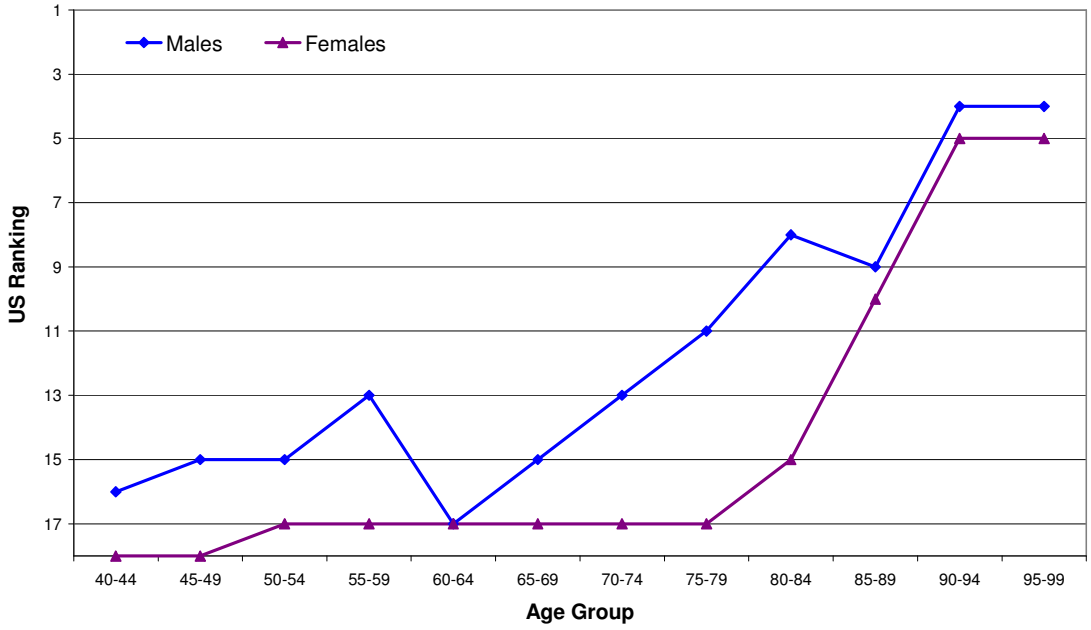
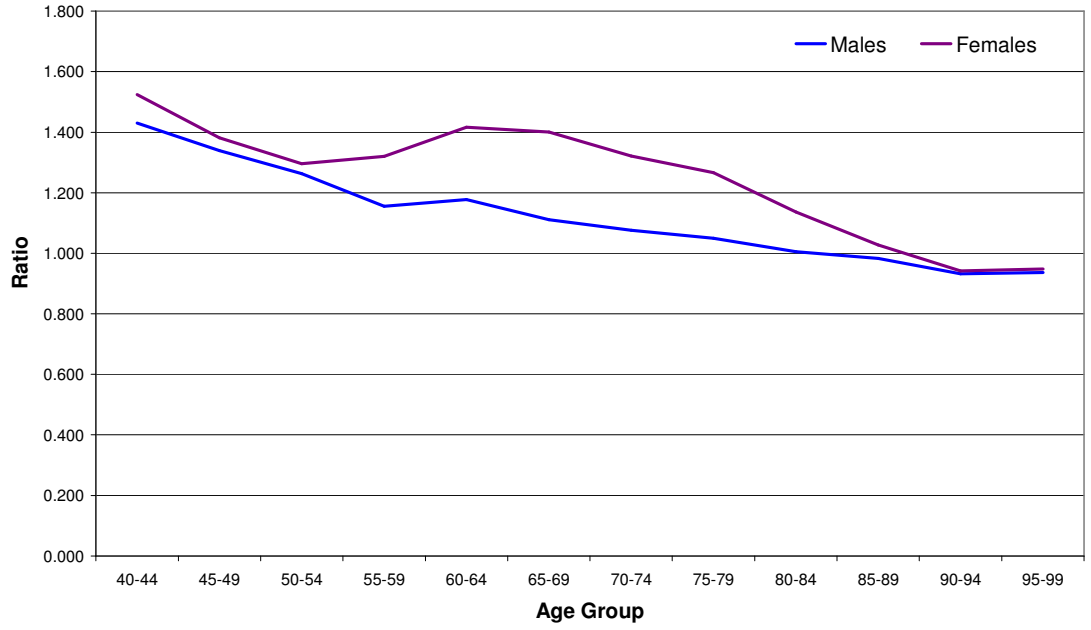


Figure 4. Ratio of US Age-Specific Death Rates (Whites Only) to the Average of a Comparison Set of 17 OECD Countries in 2005



We now consider four possible explanations of the age patterns revealed by this analysis: (1) international differences in patterns of smoking; (2) selection processes; (3) health insurance; and (4) age patterns of health care system performance.

Smoking

The major effect of smoking on population levels of mortality has been well-documented.[2] In recent decades, the smoking histories of OECD countries have differed substantially by country and by sex. During the period 1945-1985, the US had the highest per adult consumption of manufactured cigarettes of any of the countries considered (Forey et al 2002), with a very rapid increase in smoking among women. To investigate the impact of smoking on these rankings, we use a procedure developed in Preston, Glei, and Wilmoth (2009). The procedure is based on a macro-statistical analysis of the relation between lung cancer mortality, used as an indicator of damage from smoking, and mortality from other causes of death in a data set covering 20 developed countries from 1950 to 2006. In the absence of smoking, lung cancer mortality is assumed to be that observed among non-smokers in a large American Cancer Society cohort study. We draw lung cancer deaths and deaths from all causes by age group and sex for each country from the World Health Organization (WHO) Mortality Database (2008). We then remove smoking-attributable deaths from the overall death rates in each country to assess the impact of smoking on the 2005 international mortality rankings and ratios.[3] Results are shown in Figures 5 and 6.

After adjustment, the ranking of US males improves substantially between ages 65-69 and 80-84. However, the US disadvantage remains essentially unchanged for males in the younger age groups. The sharp upward pattern of rankings is maintained, but accounting for the inroads of smoking moves the age-pattern of rankings from convex to highly linear beginning at age 60-64.

For women, little change in the rankings is seen until ages 80-84; after this age, the mortality ranking of US females improves dramatically, an improvement that may not be entirely plausible. Removing smoking-attributable deaths has a very large effect on mortality ratios at younger ages; the ratio of US female death rates to death rates in the composite declines by >0.2 at ages 60-64 and 65-69. These ages coincide with the heaviest smoking birth cohorts of American women, those born around World War II (Preston and Wang 2009). Despite the major

[2] See Peto et al (1994) and Preston and Wang (2006), among others.

[3] The HMD death rates from all causes are multiplied by the fraction of total deaths due to lung cancer to obtain lung cancer death rates. The procedure used provides estimates for smoking-attributable mortality only for ages 50+. For four countries, data by cause of death were not available for the year 2005, so the closest and most recent years available were used. These were Australia (2006), Belgium (2004), Italy (2006), and Portugal (2003). The death rates and coefficients for the corresponding years were used to produce the estimates of smoking attributable deaths for these countries.

Figure 5. Ranking of US Age-Specific Death Rates Among 18 OECD Countries with and without Adjustment for Smoking Attributable Deaths

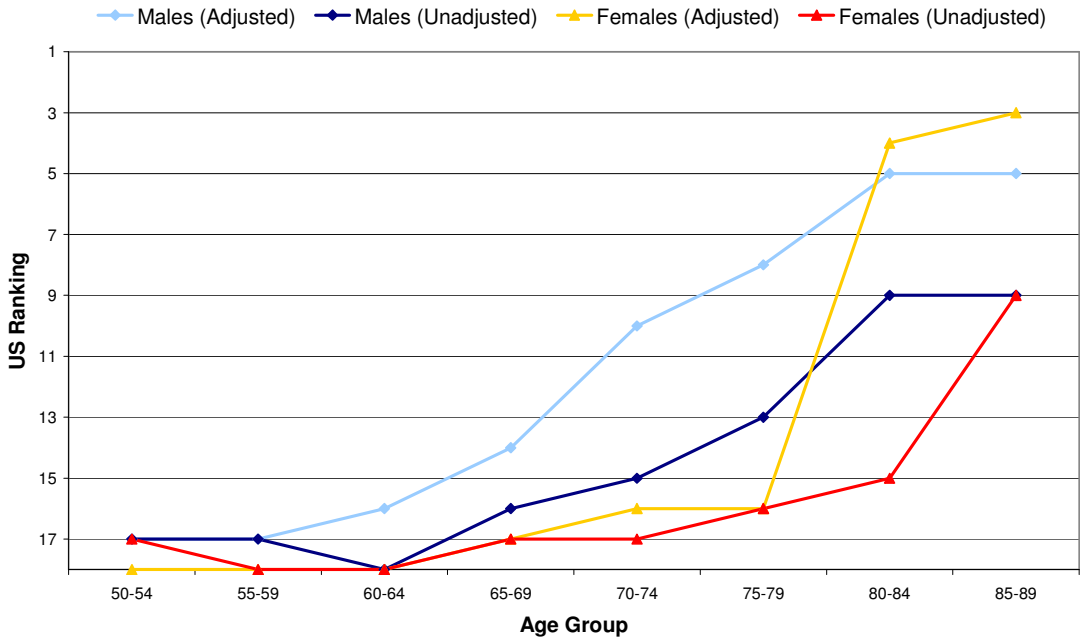
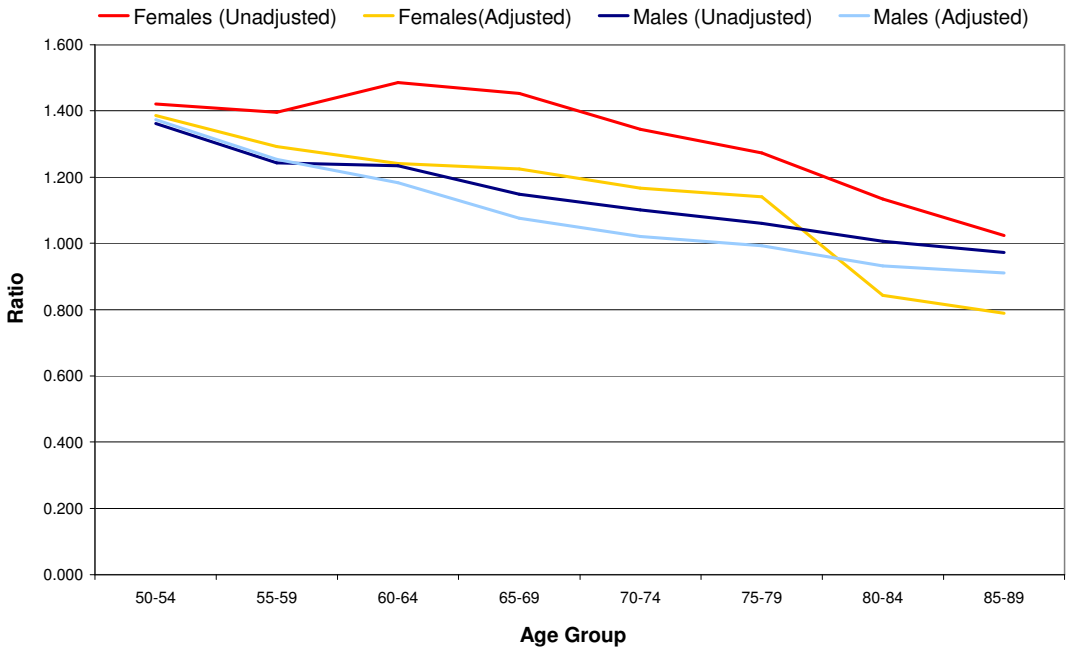


Figure 6. Ratio of US Age-Specific Death Rates to the Average of 17 OECD Countries with and without Adjustment for Smoking-Attributable Deaths



effect of smoking on the mortality of US women aged 60-69, their ranking doesn't improve relative to the composite because US death rates were so much higher to start with. The "outlier" status of US women at ages under 70 means that the large changes in ratios that result from

removing smoking deaths have little if any effect on the US ranking. On the other hand, male death rates are more closely clustered than female death rates, so that the relatively modest effect of removing smoking-attributable deaths on the US male mortality ratios translates into a perceptible effect on male rankings beyond age 60.

Given the history of cigarette consumption in the US relative to other developed countries, we expected that smoking might be an important part of the explanation for the US disadvantage at all ages, and especially so for younger females. Although the adjustment for smoking has a very large effect on American women's mortality at ages 55-74 relative to the composite, it is not sufficient to improve women's rankings substantially. Instead, sizeable improvements in rankings are produced at older ages for both men and women. Thus, allowance for smoking actually makes the age pattern of rankings sharper and steeper.

Selection

A competing explanation of the observed age patterns is selection: the sickest individuals in the US could be dying at earlier ages, leaving only the healthiest individuals to survive to the oldest ages. Such a selection mechanism would have to be stronger in the US than in other countries to produce the sharply-sloped pattern of ratios and rankings. While some sort of selection mechanisms must be operating in all populations, they do not appear especially powerful relative to the operation of common factors that raise or lower the death rates at all ages simultaneously. A large collection of life tables assembled from different countries and eras found correlations of +0.8 or higher between death rates at any two ages (Coale and Demeny 1983). Janssen et al (2005) used a cohort approach to examine the correlation between mortality at ages 55-69 and ages 80-89 for cohorts born between 1895 and 1910 in northwestern Europe. The authors consistently found positive correlations between mortality rates in these age groups for the same cohort and concluded that trends in old age mortality were predominantly determined by accumulated exposures over the life course rather than by mechanisms of selection (Ibid).

We perform our own check of the validity of the selection argument by analyzing the age-trajectory of rankings within our data set. In particular, we ask whether the correlations between ranks of death rates at younger and older ages in the same population are negative or positive. A negative pattern would be suggestive of selection. We use Spearman's rank

correlation coefficient and the Kendall tau rank correlation coefficient. These are non-parametric measures of correlation, and results of the two methods are nearly identical. For both sexes, the correlations between the ranks of any pair of age groups are all positive for both men and women, whether the United States is included in or excluded from the set of countries on which the correlations are based. We conclude that selection is not a plausible explanation of the age-patterns of ratios and rankings that we observe in the US.

Access to Health Care

About 17.2% of the population below age 65 was estimated to be uninsured in 2002 (Institute of Medicine 2004). Since individuals qualify for Medicare at age 65, it is possible that the US performs well at older ages because of older individuals' expanded access to the health care system. We explore the merits of this explanation by examining equivalent rankings and ratios in 1960, a year that predates the implementation of Medicare.[4]

Figure 7. Ranking of US Age-Specific Death Rates Among a Comparison Set of 18 OECD Countries in 1960

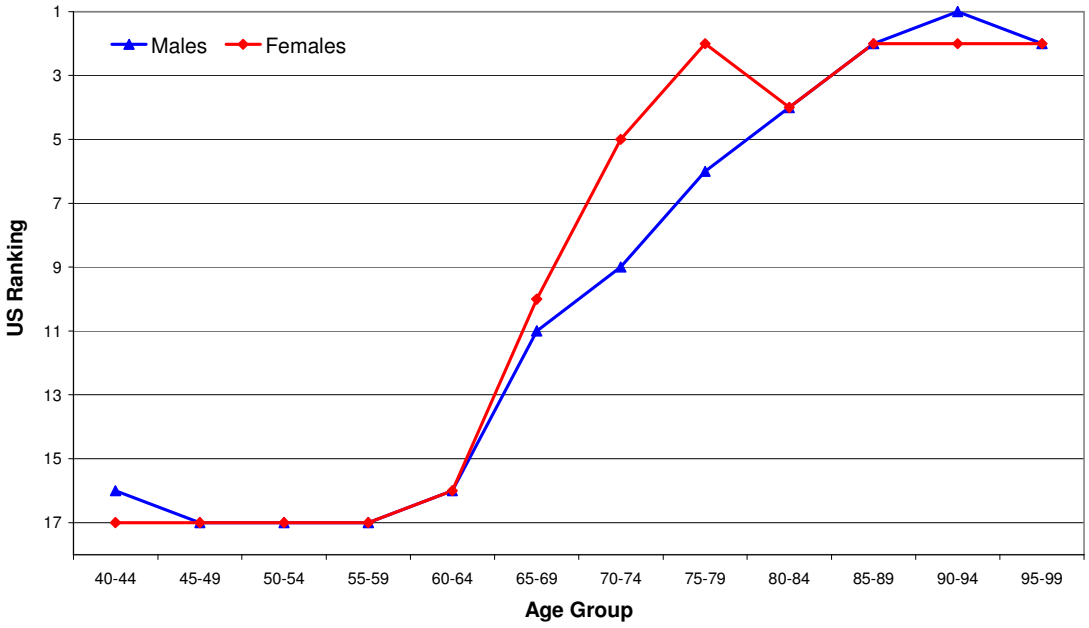


Figure 7 shows that the upward-sloping age patterns already existed in 1960. In fact, a comparison of Figures 1 and 7 will show that the US position among the comparison countries

[4] We examine the patterns in 1960 using the HMD data set for the comparison countries' death rates and the 1959-1961 NCHS life table and the 1960 Social Security Administration (SSA) life table for the US death rate. The NCHS and SSA series were very similar, with the exception of the death rates for women between ages 80-99. In those age groups, the NCHS estimates slightly higher death rates for women in the oldest age groups compared to SSA. Figure 7 depicts the rankings in 1960 using the SSA series.

has in fact systematically worsened since 1960. This deterioration is particularly clear for females. Thus, it does not appear that Medicare entitlements are responsible for the upward slope in US rankings, since the pattern was clearly established before Medicare was introduced. In fact, US rankings at ages 65-69 to 80-84 have substantially deteriorated since the introduction of Medicare.

Age Patterns of Health Care System Performance

We now review specific studies of medical performance by age in order to see whether the health care system, quite apart from health insurance issues, may be responsible for the unusual age pattern of American mortality. For example, it is possible that younger patients in the US receive less effective medical care than younger patients in other developed countries, while the US position is much better among older persons. Detailed results of these studies are discussed below. Table 1 contains a concise summary of these studies and indicates whether a US advantage exists and is greater at older ages.

Cancer

Compared to European countries, the US performs particularly well in terms of cancer screening and cancer survival. Howard, Richardson, and Thorpe (2009) have conducted the most comprehensive study of screening differences between the US and Europe. They use the 2004 Health and Retirement Survey (HRS) and Medical Expenditure Panel Surveys (MEPS) to calculate US screening rates. They use the 2004 Survey of Health, Ageing and Retirement in Europe (SHARE) and the 2006 Eurobarometer survey to calculate European screening rates. Four screening indicators were considered: mammography in the past two years, colorectal screening in the past 10 years in Europe and in the past 5 years in the US[5], pap smear in the past year, and PSA test in the past year.

US screening rates were substantially higher at all ages. Overall, European screening rates were 22-88% of the corresponding US rates. Although screening rates are inversely related to age in all countries, the decline in age was sharper in European countries than the US for all forms of cancer considered. For mammography, the ratio of European to US screening rates was 0.60 in the age group 50-64, 0.44 in the age group 65-74, and 0.35 in the age group 75+. The

[5] According to the authors, this was necessary due to differences in the wording of survey questions and may result in an understatement of the differences in screening rates between the US and Europe.

ratios for the other three screening tests showed a similar decrease with age; the US performed well at all ages and relatively better at older ages.

In these surveys, screening rates were based on respondent self-report. Medicare claims data were used to assess the quality of the US data. The authors found that while the mammography and colorectal screening rates from Medicare claims data were below the survey based rates from HRS and MEPS, they were still well above the survey based rates from SHARE. This suggests that the large observed differences in screening rates are not due to differences in the propensity to misreport screening between the US and Europe. The authors hypothesize that differences in screening rates may originate from differing approaches to screening. Most European countries have organized screening programs with upper age limits; thus, screening "invitations" may only be mailed to women in the target age group. This is in contrast to the US, where screening is relatively decentralized and without age-based limits. US residents are more likely to be screened at both the older and younger ages than are European residents (Ibid).

A number of studies have examined international variations in relative survival rates from cancer (relative, that is, to persons of the same age and sex at diagnosis). Gatta et al (2000) conducted a thorough and careful examination of survival rates using SEER and EUROCARE data, making great efforts to ensure comparability. They found that although survival rates declined with age at diagnosis for all cancers (except for breast and prostate cancer in the US and Europe and for colon cancer in the US), the decline was more marked in European patients. Other studies concur with these findings; for example, Coleman et al (1999) found that five-year survival for patients diagnosed at age 75 years or older during the 1990s was nearly 20% higher in the US than in Europe.

Colorectal cancer provides a good illustration of these trends. In Europe, 5-year relative survival rates for colorectal cancer were lower among elderly patients than among younger patients. This decline has been attributed to declining health at older ages and more advanced stage at diagnosis. In the US, relative survival for colorectal cancer did not decline with age, possibly because patterns of surgery for colon and rectum cancer patients did not vary substantially with age. In contrast, the proportion of surgically-treated patients declined with age in Europe (Gatta et al 2000).

Breast cancer was one of the diseases included in the OECD's Aging-Related Diseases

Study. In European countries, older women generally have lower breast cancer 5-year relative survival rates than their younger counterparts. The decline with age is particularly dramatic in England and Wales, where the survival rate is 80% for women aged 50-59 and only 53% for women over the age of 80. Survival rates also declined with age in Japan, Norway, and Ontario. In the remaining countries, including the US, however, older women experienced fairly similar outcomes compared to their younger counterparts in 1989-95. The survival rate was approximately 82% for both age groups in the US. The international differences in age patterns of survival were hypothesized to be attributable to differences in stage at diagnosis and screening and treatment patterns (Hughes 2003).

Early stage disease was more frequent among younger European patients (aged 45-49) than older European patients (aged 70-99) diagnosed with breast cancer between 1990 and 1992. In contrast, early-stage disease was more frequent among older US breast cancer patients than among younger breast cancer patients diagnosed in the same time period (Sant et al 2004). Stage at diagnosis is an important prognostic variable for almost every cancer and for patients at any age; however, it may be even more important for the elderly. Vercelli et al (1998) examined relative survival among elderly cancer patients in Europe and found that for many cancers, including breast cancer, the survival variation between younger and older European patients is greater at 1 than at 5 years after diagnosis. This pattern is related to the fact that the elderly generally presented with a more advanced stage. However, when breast cancer is detected early and treated with curative intent, the elderly achieve relatively good survival (Ibid).

High Cholesterol

High cholesterol is a risk factor for coronary heart disease and stroke. Crimmins, Garcia, and Kim (2009) examined the use of lipid-lowering drugs in the US, Japan, the Netherlands, and Italy. They found that the US had the highest use of lipid lowering drugs in each age group, starting with adults aged 20-29 and through 70+. The US advantage was present for both men and women, although the differences in the percent of the population taking lipid-lowering drugs between the US and the other countries were particularly large for men. For the age groups 40-49, 50-59, 60-69, and 70+, the US had the highest percent of adults who were taking lipid-lowering drugs. The ratio of the US to the average of the other three countries was highest in age group 40-49 and 50-59 for females and males, respectively. For both sexes, the ratio of the

percent being treated in the US to the average of the comparison countries was higher in the age group 70+ than in the age group 60-69.

Ischaemic Heart Disease (IHD) and Acute Myocardial Infarction (AMI)

IHD is the world's leading cause of death. A review of cross-national differences in the treatment and outcomes of IHD was conducted as part of the OECD Ageing-Related Diseases Study (Moise 2003). In order to facilitate comparisons across countries, the analysis of treatment patterns was based on data on AMI admissions from hospital inpatient databases.[6] AMI (heart attack) is a well-defined clinical condition around the world and inpatient data, which are the most reliable data in most countries, are relatively complete sources of information on acute care for heart attacks. AMI is an important medical condition to consider because of its burden of mortality in developed countries and because knowledge of effective treatment has changed in recent years. Clinical trials and other data suggest that changes in medical practices may account for a large part of the improvements observed in AMI outcomes (Technological Change in Health Care Research Network 2001).

In the OECD study, the US had the highest rates of use of both angioplasty and coronary artery bypass graft. It achieved lower case fatality rates for older persons than other countries but not for the youngest age group (40-64 years) (Moise and Jacobzone 2002). Compared to Australia, Belgium, and Ontario, Canada, the US had the highest user of catheterizations; approximately half of male and female AMI patients aged 40-64 were given a catheterization in 1996. In contrast, less than 10% of AMI patients in Italy, Norway, and the UK received catheterization. Use of catheterization decreases with age, but the steepness of the gradient differed across countries. Among female AMI patients in the US, 50% aged 40-64 received catheterization compared to 10% of those aged 85-90. The corresponding figures for the Oxford region of the UK were 4% and 1%, respectively (Ibid).

Percutaneous transluminal coronary angioplasty (PTCA) is a minimally invasive surgical procedure similar to cardiac catheterization that is increasingly being used to treat AMI. It has also been shown to reduce angina, a significant sub-category of IHD. AMI patients in the US underwent PTCA more often than patients in the comparison countries (Australia, Canada, Finland, Spain, Sweden, and the UK) for all age groups, but the largest differences were

[6] AMI cases are less diverse in terms of severity than IHD, so using outcomes data based on AMI rather than IHD admissions increases the homogeneity of the patient population.

observed for the elderly (Ibid). In 1997, the US had the highest proportion of male AMI patients undergoing PTCA in the age groups 40-64 and 80-84. Utilization of PTCA among males aged 40-64 was 38.7% in the US and 26.9% in Australia, the country with the next highest proportion of AMI patients undergoing PTCA. The corresponding figures for males aged 80-84 were 16.0% and 4.9%. Among female patients aged 40-64, a slightly higher proportion underwent PTCA in Australia than the US. Among women aged 80-84, however, 13.4% of US patients underwent PTCA compared to 2.4% in Canada, the country with the second highest use of PTCA in this age group. Moise (2003) suggests that a greater reliance on PTCA in the US may result in the US's lower readmission rates relative to the comparison countries. The US experienced particularly large increases in the use of PTCA among older patients between 1990 and 1996; use of PTCA for treating AMI patients aged 85-90 increased 2.7 times for males and 3.9 times for females (Ibid).

CABG (coronary artery bypass graft) is an intensive and complicated cardiac procedure. It is rarely used to treat AMI except in an emergency or as a follow up procedure; instead, it is used far more extensively to treat less acute forms of IHD, such as angina. CABG can be seen as a secondary prevention measure for reducing the risk of later heart attacks. Proponents of CABG (versus PTCA) argue that CABG reduces the likelihood of readmissions for IHD (Moise and Jacobzone 2002). US AMI patients in both age groups (40-64 and 80-84) were more likely to receive CABG than AMI patients in Australia, Canada, Finland, Spain, Sweden, and the UK in 1997. The proportion of male AMI patients aged 80-84 undergoing CABG was 12.4% in the US; the figure for the country with the next highest proportion, Australia, was only 3.3%. For female patients aged 80-84, these figures were 8.5% in the US and 1.2% in Canada, which had the next highest proportion of female AMI patients aged 80-84 undergoing CABG (Moise 2003).

Similar patterns have been observed in the Technological Change in Health Care Research Network (2001) study, which evaluated cross-country differences in AMI treatment from 1989-1998. This study found that intensive treatment rates for elderly heart attack patients (age 65+) in the US were only moderately different from treatment rates for nonelderly patients. In Canada, the catheterization rates for the elderly were two-thirds to three-fourths as large as for the nonelderly. In Finland and Scotland, the catheterization rate in elderly heart attack patients was only half as high as in the overall population. Similar patterns were observed in the use of

CABG and PTCA. Compared to the comparison countries, intensive procedures diffuse more rapidly among the US elderly population (Ibid).[7]

Data on one-year case fatality rates for patients admitted for AMI in 1996 were available for Australia, Canada, Denmark, Finland, Sweden, the UK, and the US. Patients aged 40-64 in the US had the third-lowest one-year case fatality rates for males and females. For the oldest age group,85-90, case fatality rates in the US were generally lower than in other countries. In this age group, males had the second-lowest and females had the lowest case fatality rates among the comparison countries (Moise 2003). The US survival advantage may be attributable to patient case mix (US patients may present with less severe cases of AMI) or greater capacity constraints in Europe (Moise and Jacobzone 2002).

Pilote et al (2003) conducted a cohort study of cardiac procedure use and outcomes among elderly patients in the US and Canada (Quebec). They were able to include nearly the entire population of elderly AMI patients in the US and Quebec by using Medicare claims data and provincial claims data. Patients 65 years and older who were hospitalized with a principal diagnosis of a new AMI between 1988 and 1994 were included in the study. Overall, the authors conclude that cardiac procedures were used much more intensively among the oldest patients in the US relative to Canadian patients in this age group (Ibid).

Hypertension

Hypertension is universally recognized as a risk factor for cardiovascular disease (CVD) and stroke. Wolf-Maier et al (2004) evaluated hypertension treatment strategies in the 1990s in the following countries: Germany, Sweden, England, Spain, Italy, Canada, and the United States. They found that hypertension treatment has been pursued more aggressively in North America than Europe, and most aggressively in the US. Based on the current standard of 140/99 mm Hg, treatment of hypertension was highest in the US (53%) and Canada (36%), and lowest in England (24%), Sweden (26%), and Germany (26%). Cross-country variation in treatment guidelines did not entirely account for the varying success in control efforts. Treatment rates increased with age in Europe, particularly for women, but remained fairly constant across age in the US. The percentage of hypertensives who had their blood pressure controlled at the 140/90 mm Hg level was the highest in the US for each age group (35-45, 45-55, 55-65, and 65-75). The

[7] Depending on the procedure, comparison countries include Canada, Finland, Sweden, Denmark, France, Japan, Italy, and Norway, among others.

proportion of hypertensive men whose blood pressure was controlled at the 140/99 mm Hg threshold increased markedly with age. This was especially true in the US, where it rose from 9% for men aged 35 to 30-44% for men over the age of 65 (Ibid).

O'Neill and O'Neill (2007) used the Joint Canada/ US Survey of Health (JCUSH), a telephone survey designed to maximize cross-country comparability of the responses, to determine the percent of patients with chronic conditions who received treatment in the US and Canada. 88.3% of US adults aged 18-64 with high blood pressure reported receiving treatment, compared to 84.1% of Canadian adults in the same age group. At older ages (65+), these percentages increase to 97.7% and 95.1% for the US and Canada, respectively.

Stroke

Proper management of hypertension has been shown to be highly effective in reducing the risk of stroke for all age groups. The burden of mortality from stroke is sizeable: in 1997, stroke deaths accounted for 10% of all deaths in OECD countries (Moon 2003). An in-depth review of stroke treatment and care was included in the OECD Aging-Related Diseases project. This report focused on ischaemic stroke, the subtype of stroke which accounts for the largest proportion of strokes and which is more amenable to treatment.[8] Ischaemic stroke is related to aging, with mortality increasing sharply with age (Moon, Moise, and Jacobzone 2003).

7-day and 30-day hospital fatality rates were calculated for patients hospitalized with ischaemic stroke in 1998. Three age groups were compared, 40-64, 65-74, and 75+.[9] For the 7-day hospital fatality rates, US women went from ranking 1st out of 9 countries in the age group 40-64 to ranking 3rd and 2nd out of 9 in the older age groups. Men started out in 5th place at ages 40-64 and improved to 2nd place in the age group 75+. Patterns were similar for the 30-day hospital fatality rates, with men showing improvement with age while women's ranking fell slightly in age groups 65-74 and 75+ relative to 40-64. For the 30-day and one-year case fatality rates, US Medicare data are used, so comparisons for the 40-64 age group cannot be performed. Counting all deaths and not simply deaths in the hospital, and limiting comparison to six regions including two in Canada, the US 30-day survival rate ranked 1st for men aged 65-74 and 75+ and

[8] Ischaemic stroke accounts for 80% of strokes in the countries under consideration, with the exception of Japan, where haemorrhagic stroke contributes a higher proportion of stroke incidence.

[9] For 7-day hospital fatality rates, the 9 countries compared were: Australia, Canada (Ontario), Denmark, Italy, Japan, Sweden, Switzerland, Great Britain (Oxford), and the United States. For 30-day hospital fatality rates, the same set of countries were compared, excluding Italy.

second for women in these ages. The US one-year survival rate among this set of populations was considerably poorer, ranking 5th of 6 for men aged 65-74 and 4th of 6 for men aged 75+. For women at these two ages, the rankings were 4th and 3rd. In these rankings, the US position was consistently better at 75+ than at 65-74 (Ibid).

Summary

To summarize this section (see also Table 1), the US has a clear cut advantage relative to other OECD countries in frequency of cancer screening and the US screening advantage increases with age. According to Gatta et al (2000), the US survival advantage also increases with age, but they do not supply the corresponding data. Since cancer is an important cause of death at older ages, the superior performance of the US health care system with respect to cancer identification and survival is a plausible contributor to the age-pattern of US rankings that we have identified.

Data on and analyses of the relative performance of the US health care system at older ages are less abundant with respect to heart disease and stroke. The US has higher proportions receiving anti-hypertensive medication and medication to control cholesterol levels than the median of other countries, but the relative proportions do not grow systematically with age. (Of course, mortality at any particular age can be affected by treatments received at younger ages, and the advantages of superior treatment may cumulate.) Surgery following a heart attack is more common in the US than in other countries and the disparity grows with age. US one-year survival rates following a heart attack are better than average among seven countries and the US advantage grows with age. Seven day survival rates from stroke are better in the US than in the median of comparison countries but one-year survival rates are worse. There is no clear pattern of change in US rankings with age.

Conclusion

We have demonstrated that the ranking of US age-specific mortality rates varies sharply by age. For both males and females, US death rates rank poorly between ages 40-75. Our paper is not addressed to this phenomenon. Possible explanations include high rates of obesity and physical inactivity at these ages and a medical system that performs more poorly for younger people than for older ones.

Our attention is instead directed to the age-pattern of mortality rankings, which show dramatic improvements with age. We have considered four potential explanations of the unusual age pattern that we have uncovered. Three of the explanations - smoking patterns, selection, and health care access - do not appear promising. While the removal of smoking-attributable deaths has an important effect on the relative level of mortality, especially for women at younger ages, the removal of smoking-attributable deaths does not erase the upward slope of US rankings and in fact produces more favorable mortality rankings at the oldest ages. Correlations between death rates at older and younger ages in our data set do not display the pervasive negative pattern that would be suggestive of powerful selection effects. In fact, they are all positive. The sharp upward slope in US age-specific mortality rankings was already present in 1960, suggesting that the advent of Medicare and its associated health care entitlements is not a decisive factor in the pattern.

The one hypothesis that is supported by our analysis is that the US health care system is performing especially well for older patients. Earlier, we documented US advantages in identification and treatment of cancer and in the treatment of heart disease (Preston and Ho 2009). Here we attempt to supplement that analysis by examining age patterns of identification and treatment among the older population itself. Such evidence is necessarily more limited. The clearest pattern emerges for cancer screening, where the ratio of US screening rates to those of other OECD countries increases with age for four major cancers. US one-year survival rates following a heart attack are also better than average among seven countries and the US advantage grows with age. Survival rates following a stroke are exceptions to this general pattern. US survival rates are superior at seven days but below average at one year, and the age patterns are not clear cut.

The possibility that health care advantages in the US grow with age is partially supported by medical expenditure data. Hagist and Kotlikoff (2005) examined per capita public expenditure on health care by age in 10 OECD countries. They find that, above age 65, the age-slope of expenditure is steeper than average in the US although several other countries are comparable. Between ages 65-69 and 80+, the increase in the public expenditure per capita in the US is third fastest after Canada and Australia (Ibid).

We believe that a strong performance of the US health care system at very old ages is likely to be contributing to the age-pattern of US mortality rankings that we have described. While it is certainly plausible that Medicare is currently enabling this pattern in important ways,

the fact that it was present before Medicare was established suggests that it may reflect more enduring features of society.

References

Arias, Elizabeth. 2009. Personal communication.

Coale, Ansley J. and Paul Demeny. 1983. *Regional Model Life Tables and Stable Populations.* Princeton University Press.

Coleman M.P., P. Babb, P. Damiecki, et al. 1999. Cancer survival trends in England and Wales 1971–1995: deprivation and NHS Region. Studies on Medical and Population Subjects No. 61. London: The Stationery Office, 1–695.

Crimmins, Eileen, K. Garcia, and J.K. Kim. 2009. Are international differences and trends in life expectancy in sync with differences and trends in health and/or disability? Forthcoming in Eileen Crimmins and Samuel Preston, *Divergent Trends in Life Expectancy*. National Research Council. Washington, D.C.

Forey, Barbara, J. Hamling, P. Lee, and N. Wald, editors. 2002. *International Smoking Statistics: A Collection of Historical Data from 30 Economically Developed Countries*. Oxford University Press. London.

Gatta, Gemma, Ricardo Capocaccia, Michel P. Coleman, Lynn A. Gloeckler Ries, et al. 2000. Toward a comparison of survival in American and European cancer patients. ***Cancer*** 89(4): 893-900.

Hagist, Christian and Laurence J. Kotlikoff. Who's going broke? Comparing healthcare costs in ten OECD countries. National Bureau of Economic Research Working Paper Number 11833. December, 2005.

Howard, David, Lisa C. Richardson, and Kenneth E. Thorpe. 2009. Cancer screening and age in the United States and Europe. *Health Affairs* 28(6): 1838-1847.

Hughes, Melissa. 2003. Summary of results from breast cancer disease study. In *A Disease Based Comparison of Health Systems*, OECD, pp. 77-94.

Human Mortality Database (HMD). 2008. *University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany).* Retrieved September 2008, from www.mortality.org.

Institute of Medicine. 2004. *Insuring America's Health: Principles and Recommendations*. National Academies Press. Washington, DC.

Janssen, F., A. Peeters, J.P. Mackenbach, and A.E. Kunst. 2005. Relation between trends in lte middle age mortality and trends in old age mortality – Is there evidence for mortality selection? *Journal of Epidemiology and Community Health* 59(9): 775-781.

Manton, Kenneth G. and James W. Vaupel. 1995. Survival after the age of 80 in the United States, Sweden, France, England, and Japan. *New England Journal of Medicine* 333(18): 1232-5.

Moise, P. and S. Jacobzone. 2002. OECD study of cross-national differences in the treatment, costs and outcomes of ischaemic heart disease. *OECD Health Working Papers*, No. 3, OECD Publishing.

Moise, Pierre. 2003. The heart of the health care system: Summary of the ischaemic heart disease part of the OECD Ageing-Related Diseases Study, pp. 27-52 in *A Disease-Based*

Comparison of Health Systems: What is Best and at What Cost? Organisation for Economic Co-operation and Development (OECD). Paris.

Moon, L., P. Moïse, and S. Jacobzone. 2003. Stroke care in OECD countries: A comparison of treatment, costs and outcomes in 17 countries. *OECD Health Working Papers*, No. 5, OECD Publishing.

Moon, Lynelle. 2003. Stroke treatment and care: A comparison of approaches in OECD countries, pp. 53-76 in *A Disease-Based Comparison of Health Systems: What is Best and at What Cost?* Organisation for Economic Co-operation and Development (OECD). Paris.

Nolte, Ellen and C. Martin McKee. 2008. Measuring the health of nations: Updating an earlier analysis. *Health Affairs* 27(1): 58-71.

O'Neill, June E., and O'Neill, Dave M. 2007. Health status, health care and inequality: Canada vs. the US *Forum for Health Economics and Policy* 10(1): 1-43.

Peto, R., A.D. Lopez, J. Boreham, M. Thun, et al. 1994. *Mortality from Smoking in Developed Countries, 1950-2000: Indirect Estimates from National Vital Statistics*. New York: Oxford University Press.

Pilote, Louise, Olga Saynina, Frederic Lavoie, and Mark McClellan. 2003. Cardiac procedure use and outcomes in elderly patients with acute myocardial infarction in the United States and Quebec, Canada, 1988 to 1994. *Medical Care* 41(7): 813-822.

Preston, S.H., I. Elo, M. Hill, and I. Rosenwaike. 2003. *The Demography of African Americans, 1930-1990*. Kluwer Academic Publishers. Dordrecht, Netherlands.

Preston, Samuel H. and Haidong Wang. 2006. Sex mortality differences in the United States: The role of cohort smoking patterns." *Demography* 43(4): 631-646.

Preston, Samuel H. and Jessica Ho. 2009. Low life expectancy in the United States: Is the health care system at fault? National Bureau of Economic Research Working Paper Number 15213. July, 2009. Forthcoming in Barney Cohen, Eileen Crimmins, and Samuel Preston, editors. *Divergent Trends in Life Expectancy at Older Ages.* National Academy Press.

Preston, Samuel, Dana Glei, and John Wilmoth. 2009. A new method for estimating smoking-attributable mortality in high-income countries. Forthcoming in *International Journal of Epidemiology.*

Sant, Milena, Claudia Allemani, Franco Berrino, and Michel P. Coleman. 2004. Breast carcinoma survival in Europe and the United States: A population-based study. *Cancer* 100(4): 715-22.

Technological Change in Health Care (TECH) Research Network. 2001. Technological change around the world: Evidence from heart attack care. *Health Affairs* 20(3): 25-42.

United States National Center for Health Statistics. 2009. ***Deaths: Final Data for 2006. National Vital Statistics Reports***. Vol. 57(14). National Center for Health Statistics. Hyattsville, MD.

Vaupel, James W. 1997. The remarkable improvements in survival at older ages. *Philosophical Transactions of the Royal Society of London: Series B – Biological Sciences* 352(1363): 1799-1804.

Vercelli, M., A. Quaglia, C. Casella, S. Parodi, et al. 1998. Relative survival in elderly cancer patients in Europe. *European Journal of Cancer* 34(14): 2264–2270.

Wolf-Maier, K., R.S. Cooper, H. Kramer, J.R. Banegas, et al. 2004. Hypertension treatment and control in five European countries, Canada, and the United States. *Hypertension* 43: 10-17.

World Health Organization. 2008. Detailed data files of the WHO mortality database. Retrieved September 2009, from www.who.int/whosis/mort/download/en/index.htm.
World Health Organization. 2009. World Health Organization Statistical Information System. Website accessed July 2009.

Table 1. Summary of Studies Performing International Comparisons of Medical Treatment at Older Ages

Study	Study Population[10]	Variable Examined	US Advantage?*	US Advantage Greater at Older Ages** (75+,80+,85+)?
Crimmins, Garcia, and Kim (2009)	Population aged 20+ diagnosed with high cholesterol in 4 OECD countries	Percent of population taking lipid-lowering drugs	Yes	Mixed
Howard, Richardson, and Thorpe (2009)	Adults aged 50+ in 17 OECD countries	Screening rates: Breast cancer Cervical cancer Colorectal cancer[11] Prostate cancer	 Yes Yes Yes Yes	 Yes Yes Yes Yes
Hughes (2003)	Patients aged 40+ diagnosed with breast cancer in 1989-1995 in 9 OECD countries[12]	Five-year relative breast cancer survival rates	Yes	No
Moise (2003)	Patients aged 40+ hospitalized for AMI, 1997, in 7 OECD countries 1996, in 7 OECD countries[13]	Proportion of AMI patients undergoing CABG and PCTA One year case fatality rates from AMI	Yes Yes	Yes Yes
Moon et al (2003)	Patients aged 40+ hospitalized with ischaemic stroke, 1998, in 9 OECD countries	7-day hospital fatality rate	Males: Mixed Females: Yes	Males: Yes Females: No

[10] Based on national probability samples unless otherwise indicated
[11] Colonoscopy, sigmoidoscopy, and fetal occult blood test
[12] Population-based cancer registries and data collected as part of OECD Aging-Related Diseases Study
[13] Data collected as part of OECD Aging-Related Diseases Study.

	in 8 OECD countries[14]	30-day hospital fatality rate	Yes	Males: Yes Females: No
O'Neill and O'Neill (2007)	Adults 18+ diagnosed with high blood pressure Adults 18+ diagnosed with diabetes in US and Canada	Percent receiving treatment Percent taking insulin or pills	Yes Yes	No Yes
Technological Change in Health Care Research Network (2001)	Patients hospitalized with AMI, 1989-1998, in 6 OECD countries and Israel and Scotland	Use of cardiac procedures[15]	Yes	Yes
Wolf-Maier et al (2004)	35+ in 7 OECD countries[16]	Hypertension treatment rates	Yes	No

* Ratio of favorable outcomes per person, US versus mean or median of other countries for all ages
** Ratio of favorable outcomes per person grows with age

[14] Data collected as part of OECD Aging-Related Diseases Study.
[15] This includes cardiac catheterization one year after heart attack, bypass surgery one year after heart attack, and one-day primary angioplasty.
[16] All surveys based on national probability sample except for Sweden, which had a regional sample.