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Life Expectancy: A Case Study

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The US Health Care System and Lagging Life Expectancy: A Case Study

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Abstract

Life expectancy in the United States fares poorly in international comparisons. Its low ranking is often blamed on a poor performance by the health care system rather than on behavioral factors. This paper compares mortality trends from prostate cancer in the United States to those in other developed countries. Prostate cancer is chosen because it can be detected at an early stage, because effective treatments are available, and because it is less heavily influenced by behavioral factors than most other chronic diseases. We find that, after the introduction of the PSA screening test for prostate cancer, mortality from the disease declined significantly faster in the United States than in the set of comparison countries. Trends in incidence and survival rates support the interpretation that the US health care system has worked very effectively to reduce mortality from this important disease. A brief consideration of breast cancer suggests that similar processes may have been at work among women.

The United States falls well behind the world's leaders in life expectancy at birth. Some of the discrepancy is attributable to relatively high infant mortality and some to high mortality from violence among young adults. But the bulk of the discrepancy is attributable to mortality above age 50, an age to which 93.7% of newborns in the United States will survive according to the US life table of 2005 (National Center for Health Statistics, 2008). Life expectancy at age 50 in the United States ranks 29th highest in the world according to the World Health Organization (WHO, 2008).

Analysts often juxtapose the poor ranking of the United States in life expectancy with the very high percentage of its gross domestic product that is spent on health care. In 2007, the United States spent 16% of its GDP on health care, by far the highest fraction of any country (Congressional Budget Office, 2007). The implication of this combination is that the United States' health care system is extremely inefficient.

But measures of population health such as life expectancy do not depend only on what transpires within the health care system-- the array of hospitals, doctors and other health care professionals, the technologies they employ, and the institutions that govern access to and utilization of them. Such measures also depend upon a variety of personal features that affect an individual's health such as diet, exercise, cigarette smoking, and compliance with medical protocols. The health care system could be performing exceptionally well in identifying and administering treatment for various diseases, but a country could still have poor measured health if personal health care practices were unusually deleterious. This is not a remote possibility in the United States, which had the highest level of cigarette consumption per capita in the developed world over a 50-year period ending in 1985 (Forey et al. 2002). Smoking in early life has left an imprint on mortality patterns that remains visible as cohorts age (Preston and Wang 2006). Recent trends in obesity are also more adverse in the United States than in most other developed countries (OECD, 2008; Cutler, Glaeser, and Shapiro 2003).

There have been several large international studies of the performance of health care systems. The largest study, by the Organization for Economic Cooperation and Development (OECD 2003), focused on cardiovascular diseases, the leading cause of death in developed countries. It demonstrated that the United States was far more aggressive than comparison countries in the use of angioplastic or cardiac bypass surgery for treatment of ischemic heart disease. The one-year fatality rate for people admitted to a hospital for

heart attacks was exceptionally low at older ages in the US, although the US rate at ages 40-64 was near the median. Stroke victims had exceptionally low seven-day hospital fatality rates in the US; one-year survival rates were moderate. One comparative study demonstrated that the United States does a better job than six comparison countries of treating hypertension, a leading cause of stroke (Wolf-Maier et al. 2004). Among a group of nine developed countries, five-year survival rates for all forms of cancer combined were highest in the US for both males and females (OECD 2003). A detailed comparison of the US and Canadian health care systems found that the US had better survival rates for all conditions examined (O'Neill and O'Neill 2007).

Medical procedures and survival rates are indicators of what happens to individuals whose health problems come to the attention of the health care system. But a health care system can also help prevent serious health problems from occurring in the first place. Access to preventive medicine would appear to be an especially problematic area in the United States because 47 million people lack any form of health insurance (DeNavas-Walt, Proctor, and Smith 2007). These people are less likely to see a doctor and thus to receive routine testing that might detect the early stages of a disease and prevent its clinical manifestations (Institute of Medicine 2001). They are also less likely to receive advice about health maintenance and disease prevention (Institute of Medicine 2001).

Such failures of the health care system may be offset to some extent by unusually effective prevention among those whom the system encompasses. If this were the case, the US might have large disparities in, but not necessarily poor average levels of, outcomes affected by preventative medicine.

In this paper, we investigate the performance of preventative medicine in the US health care system through a case study of prostate cancer. Prostate cancer is a disease that appears to have become highly amenable to preventative medicine through a test that permits early detection and through effective therapies after identification. Unlike most chronic diseases, it is not associated with cigarette smoking (Lumey et al. 1997). A link with exercise has been suggested in several studies but a review article found that "conclusions were quite variable... odds ratios [of developing prostate cancer] for men engaged in high levels of activity ranged from 0.2 to over 2.0" (Torti and Matheson, 2004: 365). Dietary risk factors are suspected but not well established. The risk of prostate cancer is somewhat higher for men with a high body mass index, but the risk is less than for other cancers

(Crawford, 2003). Genetic factors, some of them associated with race, appear to be important in the risk of developing prostate cancer (Li et al. 2007). Its relatively flat landscape of behavioral risk factors, together with its medical preventability, makes mortality from prostate cancer a purer indicator of health system performance than mortality from many other chronic diseases of adulthood.

Diseases Amenable to Medical Intervention

A highly publicized report by the Commonwealth Fund Commission on a High Performance Health System (2008) concluded that the United States lagged far behind its peers in many measures of health system performance. The most prominent index employed in tables and text was “Mortality Amenable to Health Care”. This index consists of the relative magnitude of age-standardized death rates from an aggregate of diseases thought to be amenable to health care- “deaths that might have been prevented with timely and effective care” (Ibid.: 10). The report refers to a paper by Nolte and McKee (2008) for details of the index construction. The index pertains to deaths from causes amenable to health care below age 75. The major causes of death included are ischemic heart disease, stroke, and several cancers thought to be “treatable” including breast and cervical cancer. Only half of ischemic heart disease deaths are included because some are believed not to be amenable to health care. That rule of thumb is clearly a poor substitute for an effort to attribute international variation in mortality from ischemic heart disease to its various components.

That there may be serious flaws in the index is suggested by the fact that males in the United States had a faster fall in mortality from non-amenable causes of death (an 8% decline) than from amenable ones (4%) between the latest two readings, 1997/8 and 2002/3 (Nolte and McKee, 2008). One of the important diseases classified as “non-amenable” is prostate cancer. Accounting for 31,000 deaths in 2000, prostate cancer was the second leading cause of cancer deaths among US men that year (US National Center for Health Statistics 2002). The age-standardized death rate from prostate cancer in the US declined by 18% between 1997/98 and 2002/03 (International Agency for Research on Cancer 2008).¹

¹ Data on prostate cancer mortality are taken from World Health Organization mortality data provided by the International Agency for Research on Cancer (<http://www-dep.iarc.fr/>). Age-standardized rates are adjusted to the world population in 1960 (Segi world standard).

Despite its classification as a “non-amenable” disease in the Commonwealth/Nolte-McKee study, there are good reasons to believe that mortality from prostate cancer is amenable to medical intervention. A blood test for the presence of prostate cancer, the Prostate-Specific Antigen (PSA) test, was approved by the Food and Drug Administration in 1986 (Shampo 2002). The test enables the detection of high and/or rapidly increasing levels of an antigen that often signals the presence of prostate cancer. High levels of the antigen can also be produced by other conditions; confirmation of cancer is made by biopsy.

Once prostate cancer is detected, a variety of treatments can be employed, including radical prostatectomy, radiation by beam or implanted seeds, or hormone therapy. “Watchful waiting” is also an option. Observational studies have described apparent survival advantages from radical prostatectomy and radiation therapy (e.g., Wong et al. 2006; Trock et al. 2008) but not always from hormone therapy (Lu-Yao et al. 2008). The questions of possible selection bias that are always present in observational studies add uncertainty to these results.

Uncertainty has been reduced by several recent reports of randomized clinical trials. A key study of Scandinavian men examined survival after diagnosis of prostate cancer. Men were randomly assigned to radical prostatectomy or to watchful waiting (Bill-Axelsson et al. 2005). Some of those assigned to prostatectomy did not have the operation, and some of those assigned to watchful waiting pursued radiation or hormonal therapy. Nevertheless, after a median follow-up period of 8.2 years, the group assigned to prostatectomy had cumulative proportions dead from prostate cancer that were lower by 44%, rates of disease progression that were lower by 67%, and rates of distant metastasis that were lower by 40%. All comparisons were statistically significant. A randomized trial of variation in radiation dosage reported a highly significant beneficial effect on survival of heavier doses (Pollack et al. 2002). Randomized trials of hormone therapy have produced more mixed results (Lu-Yao 2008; D’Amico et al. 2008).

Despite its power in detecting cancer and the availability of treatment to extend life, the PSA test is somewhat controversial. One reason is that, like many other medical screens, the PSA test can produce false positives: a report of potential cancer when it is not present. According to a summary of studies of the sensitivity and selectivity of PSA testing, an average of 75% of those with PSA readings above 4.0 ug/l have prostate cancer and 71% of men with prostate cancer have a PSA reading above 4.0 ug/l (Bunting 2002).

However, the main reservation about the use of the PSA test is that treatment for prostate cancer can produce impotence and/or incontinence. In addition, the biopsy required to confirm the presence of prostate cancer is unpleasant and can produce adverse effects (Melia 2005). Because of these side effects, several organizations have recommended against PSA testing (Ferrini and Woolf 1998). On the other hand, the American Cancer Society and the American Urological Association recommend that the PSA test should be offered annually to men over 50 with at least a 10-year life expectancy.

By reputation the US has been the world's leader in PSA testing, especially in the early years after the test was developed (Bouchardy et al. 2008; De Koning et al. 2002; Vercelli et al. 2000; Hsing, Tsao, and Devesa 2000). Table 1 compiles the latest data that we were able to locate on the frequency of PSA testing in various countries or regions. The age ranges used and the survey dates are not identical from country to country, preventing exact comparisons. The United States has the highest recorded percentage ever tested at older ages (prevalence) as well as the highest percentage tested in a recent period (incidence).

The National Cancer Institute's Surveillance, Epidemiology and End Results (SEER) data base is a population-based cancer registry covering approximately 14% of the US population. According to SEER, after the PSA test was introduced in the late 1980s, the recorded incidence of prostate cancer in the US rose from 119/100,000 in 1986 to a peak of 237/100,000 in 1992 (SEER 2008).² Consistent with more extensive screening, the United States identifies prostate cancer at an earlier stage, on average, than Sweden (Stattin et al. 2005) or Japan (Ogawa et al. 2008).

Population-based information about the treatment of prostate cancer is much skimpier than information about the use of the PSA test. Scandinavian countries rarely use radical therapies- radical prostatectomy or radiation- and rely primarily on watchful waiting or hormone therapy for palliation (Fleshner, Rakovitch, and Klotz 2000). Circumstances in Japan are similar (Ogawa et al. 2008). Among US men aged 65-80 in SEER who were diagnosed with low grade tumors between 1991 and 1999, 25.5% received no treatment within six months of diagnosis, 9.6% received hormone therapy, and the remaining 64.8% received either radiation or prostatectomy (Wong et al. 2006).

The combination of earlier detection and aggressive treatment in the US has produced greatly improved survival chances for men diagnosed with prostate cancer. According to SEER (2008), the 5-year survival rate (relative

² The data are for males and refer to the age-adjusted rates for all ages.

to individuals of the same age at diagnosis) was 78.0% for those diagnosed with prostate cancer in 1986 and 99.2% for those diagnosed in 2000. In Southeast England, where PSA testing is used much less frequently, the 5-year survival rate for those diagnosed in 1992–96 was only 69.5% (Melia 2005). These comparisons do not, of course, control for the stage of cancer at diagnosis.

International Trends in Prostate Cancer Mortality

In order to investigate whether the relatively aggressive use of PSA testing and therapy in the United States has produced an unusually rapid decline in mortality from prostate cancer, we have used World Health Organization Data compiled by the International Agency for Research on Cancer. This source presents age-adjusted death rates from prostate cancer for many countries since 1950. We have chosen a group of 16 economically developed OECD countries for purposes of comparison: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Japan, Netherlands, Norway, Spain, Sweden, Switzerland, and United Kingdom.³

Figure 1 compares levels of age-standardized death rates per 100,000 (all ages combined) in the United States to the mean death rate in these 16 comparison countries. With the exception of 1985, the US had higher death rates each year from 1980 to 1995. Beginning in 1996, the US had lower rates and the US advantage grew every year thereafter. By 2003, the US had death rates that were 20.4% lower than the mean of the comparison countries (data on Denmark, a country with high rates, are missing for 2003).

In order to investigate whether the faster US decline was statistically significant, we have used negative binomial regression on data for these 17 countries for the period 1981 to 2004. The dependent variable is the log of the number of deaths from prostate cancer in a particular country and year, with population size used as a statistical “offset”.⁴ Independent variables are a set of country identifiers, a set of period identifiers, and a set of US/period interactions. Six 4-year-wide time periods were used beginning with 1981–84 and ending with 2001–04. 1989–92 was chosen as the reference period. The complete regression equation is presented in the Appendix.

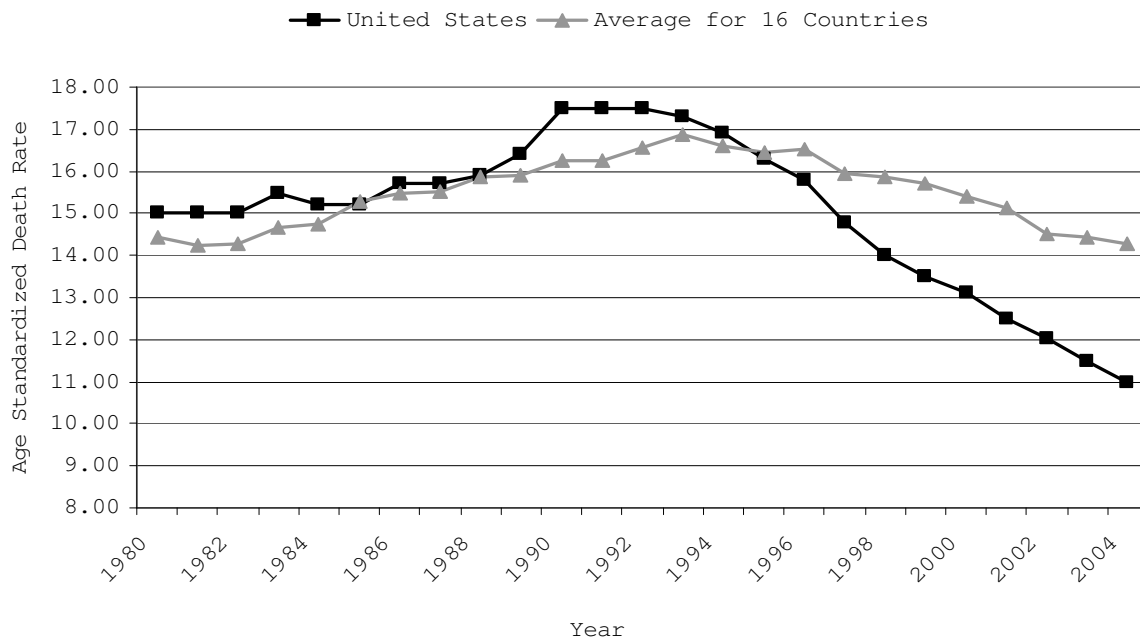
³ Using the same “standard” population employed by WHO, we have calculated age-standardized death rates for the United States in 2003 and 2004 based on data presented in US National Center for Health Statistics.

⁴ The value of population size is the number of people who would produce the observed number of deaths required to obtain the observed age-standardized death rate. Significance tests recognize the clustering of observations by country

The coefficient of the interactive variable for US observations during the period 2001-04 is -0.237, which is significant at $p < .001$. Compared to expectations based upon country and year, the US had roughly 23% lower mortality in 2001-04 than it did in 1989-92. Likewise, the coefficient of the US/period interactive variable for the 1997-2000 is -0.150 and is also significant at $p < .001$. Thus, the US had significantly faster declines in mortality than comparison countries between 1989-92 and both 1997-2000 and 2001-04. To confirm that this result was not a product of an exceptionally high US death rate in 1989-92, we also examined interactive variables for the US in 1981-84 and 1985-88. Neither coefficient was statistically significant relative to the reference category of 1989-92, suggesting that what was anomalous in the US was the rapid decline after 1989-92 rather than the rate in 1989-92 itself.

The two countries with the lowest frequency of recent PSA testing in Table 1 are Norway and the United Kingdom. These countries have had unusually slow declines in mortality from prostate cancer. Between 1985/86, when PSA testing was first approved by the FDA, and 2003/04, the age-standardized death rate from prostate cancer declined by only 1.9% in the Norway and actually rose by 2.0% in the United Kingdom. The Netherlands, the country with the third lowest frequency of testing in recent years, had a decline of 5.3% between these years (International Agency for Research on Cancer 2008).

Figure 1. Age-Standardized Death Rates Due to Prostate Cancer.

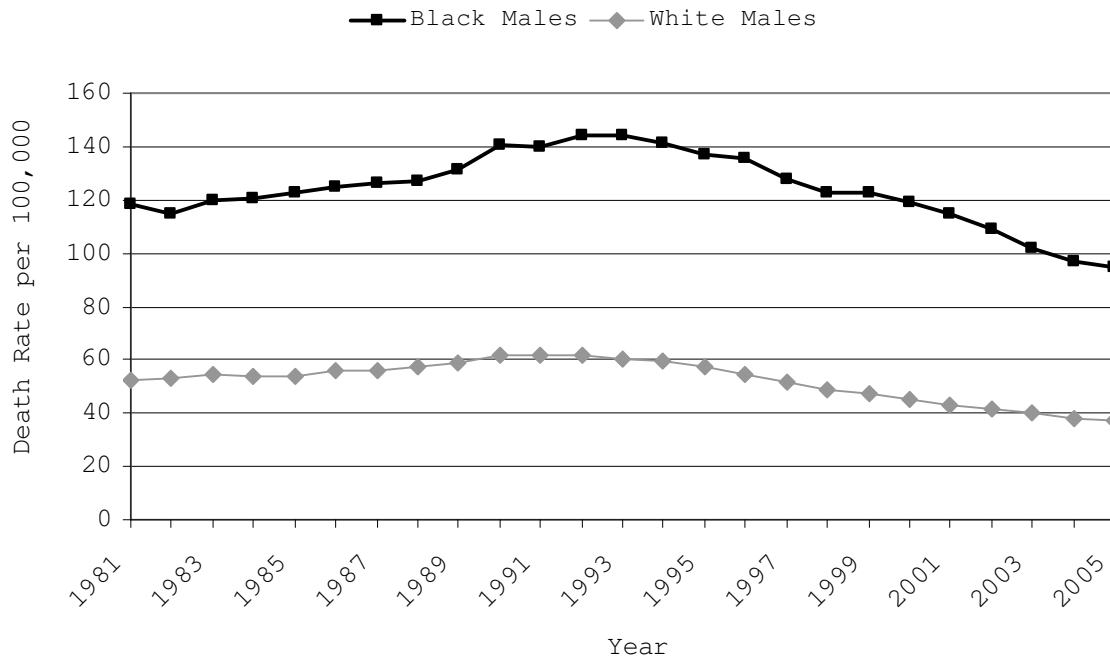


Racial Disparities

African Americans have prostate cancer death rates that are among the highest in the world (Crawford 2003). Perhaps the most prominent explanation of the racial disparity is that dark skin inhibits the absorption of Vitamin D, which is highly protective against prostate cancer (Li et al. 2007). A more tenuous connection to the health care system among African Americans is probably also a factor.

Nevertheless, a sharp decline in prostate cancer mortality in the US is evident among both whites and African Americans. Figure 2 shows trends in age-standardized death rates separately by race (National Center for Health Statistics 2008). Both whites and blacks had rates that peaked in the early 1990's. Between 1992/3 and 2004/5, the death rate declined by 32.2% for African Americans and by 36.3% for whites (Ibid.). The absolute decline in rates was much larger for African Americans. Survival trends were also attractive for both groups. The 5-year survival rate for blacks increased from 68.4% for those diagnosed in 1986, the year when PSA testing was approved, to 97.0% for those diagnosed in 2000. Among whites, the improvement was from 79.0% to 99.8% (SEER 2008).

Figure 2. Age-Standardized Death Rates from Prostate Cancer, Ages 45+, by Race: 1981-2005.



Discussion

We have demonstrated that mortality reductions from prostate cancer have been exceptionally rapid in the United States and that these declines are significantly faster than among a set of peer countries. We have argued that the rapid uptake of PSA testing in the United States after 1986, together with aggressive therapeutic regimes, is responsible for the exceptionally rapid decline in mortality. Trends in disease incidence and survival after diagnosis support this interpretation. It appears that the US medical care system has worked effectively to reduce mortality from this important cause of death.

Such a demonstration does not, of course, mean that there may not be great inefficiencies in the US health care system. And there clearly are causes of death amenable to medical intervention, such as infectious diseases, for which the US has unusually high mortality (Nolte and McKee, 2008).

Why might the US be more successful against prostate cancer than against certain other disease processes? One explanation might be that prostate cancer is not affected by the greatest health scourge among adults, cigarette smoking. Perhaps the relative position of the United States in mortality from other diseases whose treatment is heavily medicalized, such as cardiovascular diseases, would be equally attractive were they not strongly influenced by histories of heavy smoking among older adults. This interpretation is supported by evidence that hospitals and physicians in the US are unusually quick to introduce technical advances in cardiovascular treatment and to diffuse them to a wide patient base (Technological Change in Health Care (TECH) Research Network 2001).

An alternative interpretation is that prostate cancer mainly afflicts older men. By virtue of Medicare, people over age 65 have greater access to health care, including preventive care, than younger people. Over 70% of diagnoses of prostate cancer occur among men over age 65 (Crawford 2003). Men have higher average incomes than women and most physicians are men, factors that may create an advantage for men in navigating the health care system. For example, a recent study concludes that perceptions of gender discrimination are significantly associated with women's failure to receive mammograms (Dailey, Kasl, and Jones, 2008).

One possible indicator of the role of gender bias is whether levels and trends in breast cancer are also attractive in the US. Effective screening

methods are also available for breast cancer, especially through mammography, and surgery and drugs reduce the risk of death from breast cancer once it is identified. Using the same broad sweep of countries and periods that we used earlier for prostate cancer, we find that the US had a decline in mortality from breast cancer of 26.5% between 1985 and 2002, whereas our set of comparison countries had a mean decline of 16.0% (International Agency for Research on Cancer 2008).⁵ The US decline in breast cancer mortality was substantially faster than average.

The rapid decline in the US may be associated with a rapid increase in the proportion of the population being screened for breast cancer. In 1987, only 32% of American women aged 50–64 had had a mammogram within the previous two years; the figure grew to 61% in 1992 and 74% in 1998 (Schoutman et al. 2004). Five-year survival rates increased from 78.8% for those diagnosed in 1985 to 90.6% for those diagnosed in 2000 (SEER 2008). These data suggest that factors affecting levels and trends in breast cancer may be similar to those affecting prostate cancer, thereby undercutting a hypothesis of gender bias. But an added factor, a sharp reduction in the use of hormone replacement therapy for post-menopausal women, adds uncertainty to any attempt to understand breast cancer trends (Kerlikowske et al. 2007).

In conclusion, we have demonstrated that death rates from prostate cancer have declined significantly more rapidly in the US than in a set of comparison countries. The rapid decline appears to be attributable to an excellent performance by the US health care system in identifying and treating cases of prostate cancer. Reasons why US mortality levels from certain other causes of death fare poorly in international comparisons are not always obvious. It should not be automatically assumed that high mortality from a cause of death is a reflection of a poor performance by a health care system, particularly when that cause is subject to important behavioral influences.

⁵ Belgium and Denmark are excluded because they cannot supply data for both years.

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Table 1. Indicators of Frequency of PSA Testing Among Males

A. Percent of Men Ever Receiving a PSA Test

Country	Year	Age Range	Percentage of Men Ever Receiving a PSA Test	Source
Australia	2003	40+	49%	1
Austria	2006–2007	40+	54.6%	2
Canada	2000–2001	50+	47.5% ⁶	3
France	2005	40–74	36%	4
Italy	2003	50+	31.4%	5
Netherlands (Rotterdam)	1994	55–74	12.7% ⁶	6
Switzerland (Vaud and Neuchâtel Cantons)	“Early 1990s”	65+	10%	7
United States	2001	50+	75% (BRFSS)	8
	2005	50–79	62.7% (NHIS) ⁶	9

B. Percent of Men Recently Receiving a PSA Test

Country	Year	Age Range	x	Percentage of Men Receiving a PSA Test in the Past x Years	Source
Australia	1995/1996	50+	2	27%	10
Austria	2006–2007	40+	1	31.1%	2
Belgium (Limburg Province)	1996–1998	40+	1	23%	11
Canada	2000–2001	40+	1	26%	12
Italy	2002	50+	1	15.9%	5
Netherlands (Rotterdam)	1997–2000	55–74	3	20.2%	13
Norway (3 counties)	1999	50–65	1	7%	14
Spain (Getafe City)	1997–1999	55+	2	20.9%	15
Sweden	2002	50+	1	25.3% ⁷	16
United Kingdom	1999–2001	45–84	1	7%	17
United States	2001	50+	1	57% (BRFSS)	8
	2005	50–79	2	48.4% (NHIS) ⁸	9

⁶ This figure does not include men with a history of prostate cancer.

⁷ According to Sennfalt, Carlsson, and Varenhorst, 430,000 PSA tests were performed in Sweden in 2002. We assume that all were performed on men aged 50+. The UN Population Division’s estimates for Sweden’s male population (aged 50+) for 2000 and 2005 were retrieved from the UN Statistics Division’s Common Database and interpolated to give a figure for 2002 of 1,699,442.

⁸ This figure does not include men with a history of prostate cancer.

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Appendix Table 1. Coefficients of Negative Binomial Regression Predicting the Log of the Number of Deaths from Prostate Cancer[†]

<u>Variable</u>	<u>Coefficient</u> (standard error)
Period	
1981-1984	-0.111*** (0.0128)
1985-1988	-0.0483*** (0.00823)
1989-1992	0.0204 (0.0130)
1993-1996 (reference)	-
1997-2000	-0.0374 (0.0239)
2001-2004	-0.115*** (0.0289)
Observation from US	0.0193 (0.0700)
Observation from US in	
1997-2000	-0.150*** (0.0233)
2001-2004	-0.237*** (0.0294)

* p < 0.05, ** p < 0.01, *** p < 0.001

[†] The dependent variable is the log of the number of deaths, with an exposure offset equal to the size of the population that would produce the calculated age-standardized death rate.