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HOW WILL MORE OBESITY AND LESS SMOKING AFFECT LIFE EXPECTANCY?

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Introduction

Personal behaviors can have a major influence on how long people live. Two especially damaging behaviors are smoking and the poor nutrition and exercise habits that result in obesity. Estimates from the Centers for Disease Control and Prevention suggest that, in 2000, 15 percent of U.S. deaths were caused by obesity and 18 percent by smoking.[1] But obesity is on the rise while smoking is on the decline. The question is whether the benefits from less smoking will outweigh the harm from rising obesity. This *brief*, based on a recent study, projects how changes in obesity and smoking will impact life expectancy in 2040.[2]

The discussion proceeds as follows. The first two sections describe the methodologies for estimating the impact of obesity and smoking on mortality rates and for projecting how the prevalence of these behaviors will change over time. The third section presents the results, expressed as changes in future life expectancy. The final section concludes that, overall, the benefits of reduced smoking will trump the damage from increased obesity. However, the results differ by gender, with men showing a solid net gain, while women see only a small improvement.

Obesity and Mortality

The methodology for the obesity analysis consists of three steps. The first step estimates the current impact of obesity on mortality rates. The second step forecasts changes in obesity levels to 2040. The third step applies the results from step one – obesity's impact on mortality – to the results of step two – the future prevalence of obesity – to estimate how the projected changes in obesity affect future mortality.

The main data source is the *National Health and Nutrition Examination Survey* (NHANES), a nationally representative survey conducted by the National Center for Health Statistics. The NHANES was conducted periodically beginning in 1971 and has been conducted annually since 1999. The survey includes extensive medical data on individuals, collected by trained nurses. These data include current height and weight, which are used to calculate body mass index (BMI), the standard measure used in determining obesity. The survey also asks respondents to recall their weight at age 25.

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Estimating Obesity's Effect on Mortality

Regression analysis is used to assess how obesity affects mortality. The analysis uses two different measures of obesity: 1) BMI at the date of the interview ("baseline BMI"); and 2) BMI at age 25.[3] These measures rely on NHANES survey data from 1988-1994 and 1999-2002. The baseline BMI measure has four categories: Normal, Overweight, Obese I, and Obese II-III; for "age-25 BMI," the two obese categories are merged. In addition, due to strong evidence that the relative risk of death for obese individuals declines with age, an interaction term for age and the two obese categories is included.[4] The basic equation is:

Death rate = f (baseline BMI category, age-25 BMI category, age, age-obesity interaction, sex, other demographic factors)

As expected, both measures of obesity are related to an increased risk of death, and the age-obesity interactions indicate a decreasing mortality risk of obesity by age. These results, which provide the risk of death for a given individual, are then applied to the projections of obesity prevalence for the sample population, described below.

Projecting Changes in Obesity to 2040

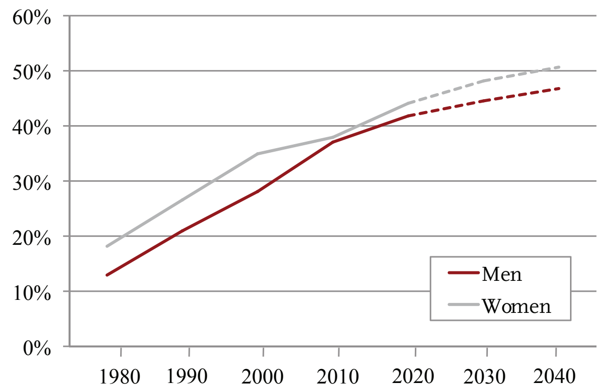
Both obesity measures – baseline obesity and obesity at age 25 – are projected to 2040. The projections start with a sample of individuals age 25-84 in 2010. Over time, this initial sample changes as some members die and as, after each decade, a new cohort age 25-34 is added.

The procedure for projecting growth in the first obesity measure is as follows. Historical BMI data are used to calculate the "transition probability" of moving from non-obese to obese (or vice versa) during different 10-year periods.[5] For example, among individuals with normal BMI in 1980, 67 percent were still in the normal category in 1990 while 30 percent had moved into the overweight category and 3 percent ended up as obese. So those starting out with normal BMI had a 3-percent chance of becoming obese during the period.

The results of this analysis showed that the probability of moving up to a heavier weight category rose between the 1980s and the 1990s but then stabilized between the 1990s and the 2000s. Therefore, data from the relatively stable 1998-2008 period were used to generate the transition probabilities needed for the projections.

The transition probabilities were then applied to the 2010 baseline population to project changes in the prevalence of obesity over time. So, for example, consider individuals who were age 50 in 2010. Their obesity prevalence is projected every five years from age 50 to age 80 (2010 to 2040).[6] This same process is used for all of the age groups in the 2010 baseline population. The combined results for all age groups show that, by 2040, nearly half of the adult population will be obese, up from about 38 percent in 2010 (see Figure 1).

Figure 1. Actual and Projected Trends in Obesity Prevalence among U.S. Adult Population, 1976-2040



Source: Preston et al. (2013).

For the age-25 BMI measure, fewer projections are necessary because everyone in the 2010 baseline sample is already age 25 or over, so BMI can be calculated directly from the NHANES interview responses. Projections of age-25 obesity are thus only needed for the younger cohorts that are added to the sample over time – those who are not yet age 25 in 2010.

The final step in the obesity analysis is to apply the coefficients for the impact of obesity on mortality, described above, to the projections of the prevalence of obesity.[7] The results of this exercise determine how the projected change in obesity from 2010-2040 affects future mortality.

Smoking and Mortality

The methodology for the smoking analysis is broadly similar to that for obesity – estimate the relationship between smoking and mortality; determine the future prevalence of smoking behavior; and apply the results of the current relationship to the prevalence of future behavior.

Data on smoking come from the *National Health Interview Survey* (NHIS), another nationally representative survey conducted by the National Center for Health Statistics. This survey has been conducted annually since 1957; the data used in the analysis cover 1965-2009.[8] These data allow for an assessment of birth cohorts stretching back to the late 19th century. Such a lengthy period is necessary due to the long lag between smoking and its mortality impact. For example, smokers often do not die from lung cancer until decades after they pick up the habit.

The NHIS includes several questions on smoking, including whether an individual is (or has been) a smoker, when he started, and when he quit. These data were used to calculate the average number of years spent as a smoker *before age 40*.

Estimating Smoking's Effect on Mortality

While the risk of death from smoking depends on several smoking-related behaviors, the death rate from lung cancer is one clear indicator of the cumulative effects of smoking.[9] Nearly 90 percent of U.S. lung cancer deaths are related to smoking.[10] Therefore, to assess smoking's effect on mortality, the analysis starts with the relationship of smoking to lung cancer deaths and then considers the effect on other types of deaths.

A regression equation is used to relate lung cancer mortality to age and average smoking behavior for each birth cohort. The basic equation is:

Lung cancer death rate = f (age, years as a smoker before age 40)

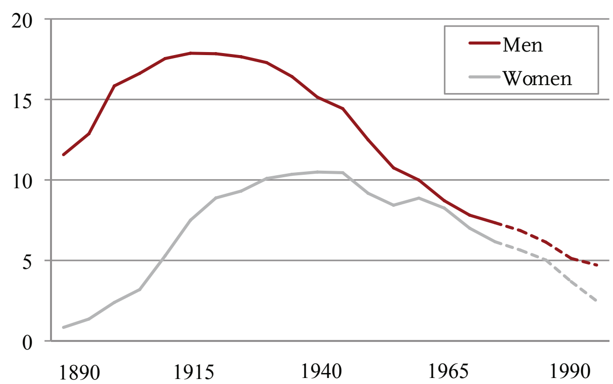
Armed with these results, the next step is to assess smoking's influence on other causes of death, such as heart disease. Here, the analysis relies on the historical relationship between lung cancer deaths and all other deaths. This relationship is assumed to remain constant so that, as lung cancer deaths are projected to decline along with smoking, all other deaths are reduced accordingly.[11] Together, these results are an indicator of the full effects of smoking on mortality.

Projecting Changes in Smoking

Since smoking behavior is only measured prior to age 40, only limited projections were needed for the period 2010-2040. The reason is that, for anyone 40 or older in the 2010 baseline population, the measure was calculated directly from the NHIS interview responses. For cohorts younger than age 40 in 2010, the measure was projected based on activity at younger ages.

Figure 2 shows the average number of years as a smoker before age 40 by birth year. All of the cohorts included in the analysis – those alive in 2010 – appear in the figure.[12] Overall, smoking used to be much more prevalent among men than women, but it peaked with men born between about 1910-1920 and then declined rapidly. Female smoking behavior peaked much later, with those born around 1935-1940, followed by a more gradual decline. The final step is to apply the results from the smoking-mortality analysis to the smoking prevalence data, by cohort, shown in the figure to estimate the effects of changes in smoking behavior on mortality from 2010-2040.

Figure 2. Mean Number of Years Spent as a Cigarette Smoker before Age 40, for Birth Cohorts from 1885-1995



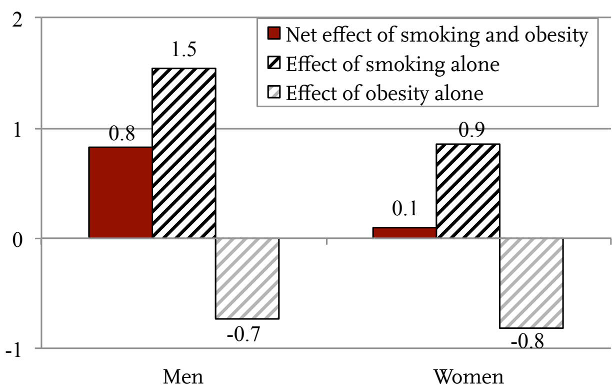
Source: Preston et al. (2013).

The Results

A common way to present mortality results is to translate them into life expectancy. This final step produces a simple summary measure: changes in life expectancy at age 40. For the purposes of this analysis, the risks of death from obesity and smoking are assumed to be independent of each other, so they are simply added together to produce the net result.[13]

Figure 3 shows the impact of the changes in obesity and smoking on life expectancy at age 40 in 2040.[14] The first bar in each cluster is the net impact on life expectancy, followed by the separate contributions of obesity and smoking. For men, the benefits of reduced smoking clearly trump rising obesity, with a net gain of 0.8 years in life expectancy. For women, smoking and obesity roughly cancel each other out, with just a small net gain. The main reason for this discrepancy is that, compared to men, women see less of a decline in smoking during the projection period because their smoking behavior prior to age 40 peaked later and declined less. Thus, while the effect of rising obesity is nearly the same for both men and women, declines in smoking add 1.5 years to male life expectancy and just under 1 year to female life expectancy.

Figure 3. Projected Effect on Life Expectancy at Age 40 of Changes in Smoking and Obesity Between 2010 and 2040, in Years



Source: Preston et al. (2013).

Conclusion

The two major behaviors that affect life expectancy have been headed in opposite directions. Smoking rates have been dropping for decades while obesity has been climbing. Over the next 30 years, the net impact of these behaviors on life expectancy is estimated to be positive, though this result is driven by men.

Both the gains from reduced smoking and the losses from increased obesity are large compared to overall gains in life expectancy projected by other researchers. For example, in 2005, the U.S. Social Security Administration projected gains in life expectancy at age 40 of about 2.6 years for men and 2.2 years for women between 2010 and 2040.[15] The projected gains in life expectancy from smoking alone are equal to about half of this total gain, while obesity imposes a penalty equal to roughly a third of the gain. Given their prominence, both smoking and obesity merit continued monitoring and analysis.

Endnotes

1 Mokdad et al. (2004, 2005).

2 Preston et al. (2013).

3 For age-25 BMI, measured height at the date of interview is used for individuals of all ages because self-reported height at age 25 was not available in the NHANES data from 1988-1994.

4 Prospective Studies Collaboration (2009).

5 In addition to current BMI and BMI at age 25, the survey asks respondents to recall their weight from 10 years prior to the survey. These responses are combined with current height to estimate “recall BMI” for each respondent, and are adjusted to correct for common reporting errors as discussed in Flegal et al. (1995). The combination of “corrected recall BMI” and current BMI is used as a data input for estimating the probability of transition between different BMI categories over a 10-year period.

6 This example just uses a single age for simplicity. For the analysis, five-year age groups were used.

7 Specifically, the coefficients are multiplied by the percentage of the total sample population projected to be obese and the percentage obese at age 25.

8 Data on smoking by cohort are based on Burns et al. (1998); which used 15 NHIS surveys from the 1965-1991 period. David Burns also supplied unpublished estimates through 2001. This series was then further updated to 2009.

9 These behaviors include the number of cigarettes smoked per day, the degree of inhalation, and the tar content of the cigarette.

10 This figure comes from Oza et al. (2011). The analysis in this *brief* obtains historical data on lung cancer deaths from several sources: Vital Statistics of the United States, the World Health Organization/International Agency for Research on Cancer, and the Centers for Disease Control and Prevention.

11 For details on the procedure used to connect lung cancer mortality to smoking-related mortality from all other causes, see Preston, Glei, and Wilmoth (2011). For a discussion of the uncertainty analyses used to assess the estimated impacts of smoking and obesity on mortality, see Preston et al. (2013).

12 As with the obesity analysis, the individuals in the smoking sample are grouped into five-year age cohorts.

13 See Preston et al. (2013) for a discussion of possible interactions between mortality risks for obesity and smoking.

14 These results differ somewhat from Stewart, Cutler, and Rosen (2009), who forecast that the negative effects of obesity would outweigh the positive effects of reduced smoking during the 2005-2020 period. The main reason for the difference is the different period of analysis; the results for 2010-2020 look more similar to Stewart, Cutler, and Rosen (2009). Another reason is that the results show a smaller role for obesity than Stewart, Cutler, and Rosen (2009), probably due to a slower increase in obesity and a lower associated mortality risk.

15 Bell and Miller (2005).

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