Subjective Survival Expectations: Mortality Differentials by Body Weight Status

Abstract

<u>Introduction</u>

BMI and Mortality

A recent prospective collaborative study suggests that in the present decade, about 29% of vascular deaths and 8% of neoplastic deaths in late middle age in the US would have been attributable to having a Body Mass Index[1] (BMI) greater than what is considered as normal[2]. For the UK, the corresponding proportions would have been about 23% and 6%, for vascular and neoplastic deaths respectively (Prospective Studies Collaboration, 2009). Calle and her colleagues suggest that the patterns of overweight and obesity in the US could account for 14% and 20% of the deaths from cancer for males and females respectively (Calle et. al, 2003).

Obesity was found to increase the risk of overall and circulatory disease mortality and to substantially increase diabetes mortality. Compared with normal weight individuals obese ones were found to be 2.8 times as likely to die of diabetes, and morbidly obese (defined as BMI>40) 4.7 times as likely to die of diabetes (Rogers et al., 2003). Adams and his colleagues found an increased risk of all cause mortality for both overweight and obese individuals, males and females, in all racial and ethnic groups, and at all ages (individuals were older than 50 at baseline and were followed up for 10 years). For those who never smoked, at age 50 the increment was between 20-40% among the overweight, and between 200-300% among the obese individuals (Adams et al., 2006).

Obesity has also been found to be associated with decreased life expectancy relative to people in the normal weight category (Allison et al., 1999; Flegal et al., 2005; Mokdad et al., 2004). Olshansky and colleagues (2005) anticipated that unless something is done to modify the trend of the obesity prevalence that is accompanied by comorbidities such as diabetes, life expectancy at birth in the US could level off or even decline by mid-century. According to estimations performed by Olshansky and his coauthors the loss of life expectancy at birth due to obesity is in the order of one third to three fourths of a year. The authors considered these results, based on cross-sectional data for individuals 19 years and older, as a conservative estimate. Other authors as well (Fontaine et al., 2003) have also suggested losses of life expectancy in the US. Peeters and colleagues found that obesity and overweight at 40 years of age were associated with decreases in life expectancy similar to those seen with smoking (Peeters et al., 2003).

Subjective Survival and Actual Survival

Subjective probabilities of survival have been shown to behave and aggregate as population probabilities and to covary with other variables like socioeconomic status or smoking as actual probabilities vary with the same variables (Hurd and McGarry, 1995). Survival expectations were also proved to be consistent with observed survival patterns (Smith et al., 2001a). Elder (2007), based on data from the first seven waves of the Health and Retirement Study (HRS 1992-2004), found that, on average, respondents aged 50-64 show to be pessimistic about their survival to relative young ages and optimistic regarding their survival to more advanced ages (particularly 85 and more). However, this same study showed that survival probabilities predict in-sample mortality well at ages less than 65 (but less so past age 65). Over all Elder states that, despite its shortcomings, not only subjective probabilities predict actual mortality, but also, as Popham and Mitchell (2007) stated, they may contain information that is captured neither by self-reported health status nor by objective measures of health limitations.

Perozek (2008) argued that individuals are particularly capable to predict their own mortality based on knowledge regarding their genetic background as well as their environmental and behavioral risk factors.

---

[1] BMI= (weight in kilograms / (height in meters)^2)

[2] According to the World Health Organization the classification of individuals by BMI is as follows: Underweight: 18.5<BMI; Normal Weight: 18.5≤BMI<25; Overweight: 25≤BMI<30; and Obese Class I: 30≤BMI<35; Obese Class II: 35≤BMI<40; and Obese Class III: BMI≥40

Using 1992 HRS data, Perozek constructed subjective cohort life tables that predicted the narrowing of the 1992-2004 gender mortality gap showed in the 2004 Social Security Administration's revision of US life expectancy. In this revision, male life expectancy was corrected up and female life expectancy was corrected down. Subjective life expectancies for men showed to be approximately similar to the 2004 life tables, but for women they were lower.

Delavande and Rohwedder (2008) compared the actual survival function obtained from 1992-2006 HRS data with the subjective survival function obtained from the same study. Their results suggested that "subjective survival probabilities provide a suitable alternative for estimating differential mortality by wealth, income and education" (Delavander and Rohwedder, 2008, p.9). As an application, the authors used survival expectations to study differential mortality by wealth in several European countries (using 2004 SHARE[3] and 2004 ELSA[4] data) and the US (1992 and 2004 HRS data). They found that overall the gradient by wealth tercile is quite comparable among European countries as a whole and the US although it is somewhat smaller in Europe. The authors considered that their approach's performance was well enough to constitute an alternative for international mortality comparisons in the cases where comparable longitudinal mortality data is not available.

Objective

Subjective survival expectations showed to be accurate enough so as to be used as a valid alternative when mortality studies are not feasible (Perozek, 2008) and as mentioned earlier they also showed to allow the study of differential mortality by income, education, and wealth as well (Delavande & Rohwedder, 2008). The main purpose of this study is to investigate the use of subjective survival estimations in the analysis of differential mortality by body weight categories as measured by BMI. In particular, we are interested in compare for individuals classified as being in the normal weight category with those classified as being in the overweight and obese categories.

Data

For the present study, we use data from the Health and Retirement Study (HRS). The HRS is a longitudinal survey that was designed to gather information on persons from pre-retirement into retirement in the US. The first's wave (1992) target population includes individuals aged 51-61 living in households. A total of 15497 individuals, including spouses or partners regardless of their age, were eligible for interviews in 1992 from whom 12654 respondents were finally interviewed. At present, the survey consists of a total of nine waves with interviews conducted every two years. The subsample for this study, obtained from the RAND HRS Data File Version "H", comprises all the individuals, targets and spouses, aged 50 to 60 at baseline (1992): a total of 4369 males and 5116 females.

In 1992, the question on subjective survival probabilities was as follows:

"Using any number from zero to ten, where 0 equals absolutely no chance and 10 equals absolutely certain,

- What do you think are the chances that you will live to be 75 or more?"
- And how about the chances that you will live to be 85 or more?"

Therefore, in 1992 there were eleven possible answers to these questions.

This format was maintained for the 1996 and 1998 HRS rounds. The question was changing over time and in 2000, it took the following format, which is the one still in use:

- "How sure are you that you are going to live to be …

[3] Survey of Health Aging and Retirement (SHARE): data from Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, and Sweden.

[4] English Longitudinal Study of Aging (ELSA)

75 years or more (if the respondent's age is less than or equal to 65 years old)?
80 years or more (if the respondent's age is 69 years or less)?
85 years or more (if the respondent's age is between 70 and 74 years old)?
90 years or more (if the respondent's age is between 75 and 79 years old)?
95 years or more (if the respondent's age is between 80 and 84 years old)?
100 years or more (if the respondent's age is between 85 and 90 years old)?"

(As before 0 representing "Absolutely no chance" and 100 "Absolutely certain")

Method

Following Delavande and Rohwedder (2008), we first compare mortality differentials by body weight categories based on the experience of the 1992 HRS respondents for whom there is information about their survival to age 75 (individuals aged 61-66) with the subjective mortality differentials of the same individuals (based on their subjective survival probabilities). Second, we compare mortality differentials elicited from subjective survival estimates in 1992 with those elicited in 2006 for individuals 50-60 years of age which constitute the population in which we are mainly interested and for whom actual survival cannot be estimated yet. To estimate subjective mortality differentials we follow the theoretical framework proposed by Delavande and Rohwedder (2008).

Under this framework, the survival function $I_{i,TA} = X_{i,t}\beta + \varepsilon$ represents the probability that respondent *i*, who has *X* characteristics at time *t*, has of being alive at the target age *TA* (age at time *t* < *TA*). The survival function $I_{i,TA}$ determines an outcome $A_{i,TA}$ that is defined as follows:

$$A_{i,TA} = 1 \text{ if } I_{i,TA} = X_{i,t}\beta_i + \varepsilon_i > C$$
$$A_{i,TA} = 0 \text{ if } I_{i,TA} = X_{i,t}\beta_i + \varepsilon_i < C$$

Here, *C* is a constant and ε_i are individual-specific shocks that affect individual survival. The ε are iid across individuals. Given this assumption the objective probability for an individual of being alive at *TA* conditional to X_t is:

$$P(A_{i,TA} = 1 / X_{i,t}) = P(X_{i,t}\beta_i + \varepsilon_i > C)$$

and denoting as *G* the cumulative distribution of ε, we have that:

$$P(A_{i,TA} = 1 / X_{i,t}) = G(X_{i,t}\beta_i - C) \qquad (1)$$

If individuals know the shape of their survival function and the characteristics X_t, their predictions about their chances of surviving to the target age ($\Pi_{i,TA}$) is given by[5]:

$$\Pi_{i,TA} = G(X_{i,t}\beta_i - C) \qquad (2)$$

Preliminary Results

Table 1 shows the estimates of differential mortality by body weight category for individuals aged 61 to 66 year in 1992. Individuals this age may have reached the target age of 75 at any point between 1992 and 2006. For individuals in the two highest obesity classes we observe that the coefficients are almost identical and we could not reject the hypothesis that they were equal (the same for the Overweight category). For the Obese Class I category the hypothesis of equality of coefficients could be rejected at a 0.1 level.

[5] The implicit assumption is that there is no systematic unexpected longevity shift occurring between time *t* and the time respondents reach the target age *TA*. If it is not the case then at least the shift should affect proportionally in a way that no differentials should be observable.

Table 1 **Differential Mortality Estimates by Body Weight Categories**

	Logit on Actual Survival to Age 75 (N=1381)		Quasi Maximum-Likelihood (logit) on Subjective Survival to Age 75 (N=1381)	
	Coefficients	**p-value**	**Coefficients**	**p-value**
Body Weight Categories (vs. Normal Weight)				
Overweight (25≤BMI<30)	0.121	0.395	-0.032	0.815
Obese Class I (30≤BMI<35)	0.267	0.177	**-0.307**	**0.082**
Obese Classes II/ III (35≥BMI)	**-0.486**	**0.071**	**-0.488**	**0.061**
Age	0.109	0.008	0.056	0.140
Male (vs. Female)	0.541	0.000	0.260	0.060
Constant	-6.487	0.014	-2.978	0.222

Table 2 shows the results of the elicited mortality differentials in 1992 and 2006 for individuals aged 50-60.

Table 1 **Estimates of Mortality Trends by Body Weight Categories based on Subjective Survival to Age 75**

	Quasi Maximum-Likelihood (logit) on Subjective Survival to Age 75 in 1992 (N=7960)		Quasi Maximum-Likelihood (logit) on Subjective Survival to Age 75 in 2006 (N=8720)	
	Coefficients	**p-value**	**Coefficients**	**p-value**
Body Weight Categories (vs. Normal Weight)				
Overweight (25≤BMI<30)	-0.145	**0.008**	-0.017	0.848
Obese Class I (30≤BMI<35)	-0.277	**0.000**	-0.179	**0.063**
Obese Classes II/ III (35≥BMI)	-0.434	**0.000**	-0.501	**0.000**
Age	0.002	0.814	-0.001	0.954
Male (vs. Female)	0.178	0.000	0.338	0.000
Constant	0.524	0.219	0.278	0.691

We observe that compared with Normal Weight individuals the odds ratios for the other body weight categories decrease for both 1992 (odds ratios of 0.87, 0.76, and 0.65 for Overweight, Obese Class I, and Obese Classes II or III respectively) and 2006 (0.98, 0.84, and 0.61) waves. However, we cannot reject the hypothesis that the 1992 odds ratio for all body weight categories are equal to the 2006 odds ratio for the same categories.

These results are showing: first, that we could use subjective survival in order to estimate differentials in mortality by body weight categories; second, that those differentials do not seem to have changed over the 14-year period considered. We should mention that the prevalence of Obesity Class I increased by 5% between 1992 and 2006 for individuals in the age range 50-60, but that it doubled for the combined category Obesity Classes II/III.[6]

[6] This is consistent with findings by Sturm (2003 and 2007), who found that in the US severe obesity is increasing at a much faster rate than moderate obesity.