NBER WORKING PAPER SERIES

PREDICTORS OF MORTALITY AMONG THE ELDERLY

Michael D. Hurd
Daniel McFadden
Angela Merrill

Predictors of Mortality Among the Elderly
Michael D. Hurd, Daniel McFadden, and Angela Merrill
NBER Working Paper No. 7440
December 1999

ABSTRACT

The objective of this paper is to find the quantitative importance of some predictors of mortality among the population aged 70 or over. The predictors are socio-economic indicators (income, wealth and education), thirteen health indicators including a history of heart attack or cancer, and subjective probabilities of survival. The estimation is based on mortality between waves 1 and 2 of the Asset and Health Dynamics among the Oldest-Old study. We find that the relationship between socio-economic indicators and mortality declines with age, that the 13 health indicators are strong predictors of mortality and that the subjective survival probabilities predict mortality even after controlling for socio-economic indicators and the health conditions.

Michael Hurd
RAND Corporation
1700 Main Street
Santa Monica, CA 90407
and NBER
mhurd@rand.org

Daniel McFadden
University of California, Berkeley
Department of Economics
549 Evans Hall #3880
Berkeley, CA 94707-3880
and NBER
mcfadden@econ.berkeley.edu

Angela Merrill
University of California, Berkeley
Program in Health Services and Policy Analysis
Berkeley, CA 94707-3880
amerrill@uclink4.berkeley.edu

1. Introduction

Mortality risk is a fundamental determinant of consumption and saving in a life-cycle model. Understanding the behavioral reactions to variation in mortality risk is important from a scientific point of view and from a policy point of view. The reaction will reveal the degree of risk aversion, which is an important behavioral parameter. The economic status of the oldest-old will depend on their consumption and saving choices in the years closely following retirement. Under the life-cycle model the predicted changes in life expectancy will have an effect on national saving beyond what would be forecast from a compositional effect.

Mortality risk in the population may be adequately measured by lifetables; however, individuals are likely to have additional information about their life chances and use that information in making consumption and saving decisions. Some of that information may be related to observable characteristics such as health status and socio-economic status (SES). Accounting for the relationship between SES and mortality (the SES gradient) is particularly important. The gradient is important because it causes difficulties in predicting the economic status of a cohort and in understanding life-cycle behavior from cross-section variation in wealth. Besides cohort effects that would, by themselves, cause wealth to decline with age in cross-section, the mortality gradient will cause wealth to increase both in cross-section and in panel. As a cohort ages those with less wealth die, leaving survivors from the upper part of the wealth distribution. Thus, even if no couple or single person dissaves after retirement, the wealth of the cohort would increase with age. This makes it difficult to study life-cycle wealth paths based on synthetic cohorts, which will eliminate cohort differences in lifetime time resources but not differential mortality. These difficulties carry over to studies of income and consumption in synthetic cohorts.

Yet, it is likely that individuals have subjective information about their own survival chances that cannot be discovered from mortality rates stratified by observable covariates such as SES. First, some personal characteristics are not easily measured, so they cannot be used as stratifying variables. Second, individuals may misperceive their survival chances, choosing consumption based on subjective yet biased life expectancy. If we are to understand consumption choices we need to have observations on the subjective variables that individuals use in making their choices. Third, even if we could stratify by many characteristics and understand average bias, there surely would remain considerable heterogeneity in subjective survival probabilities: understanding that heterogeneity would help in the estimation of life-cycle models.

To model and use heterogeneous information about survival chances in life-cycle models is a multi-step process. First, we need to find the observable correlates of mortality and measure their effects. Second, we need to measure the perceptions of individuals about their own mortality risk, and, given observable characteristics, to find if these perceptions have explanatory power for mortality. Third, we need measures of mortality risk that embody all of our knowledge about heterogeneity in models of decision making. This paper addresses the first two of these steps.

Differential mortality by socio-economic status (SES) has been observed over a wide range of data and populations: mortality rates are high among those from lower SES groups (Kitagawa and Hauser, 1973; Shorrocks, 1975; Hurd, 1987; Hurd and Wise, 1989; Jianakoplos, Menchik and

Owen, 1989; Feinstein, 1992). However, because of data limitations the measures of SES have typically been occupation or education. In the Health and Retirement Study (HRS) and the Asset and Health Dynamics Study (AHEAD) there is scope for expanded studies of differential mortality because these are panel surveys with considerable age density and they obtain extensive data on income, wealth and health conditions in addition to occupation and education. The AHEAD data in particular offer opportunities for increasing our knowledge of the gradient because the population (age 70 or over at baseline) has been not been studied to the extent to which younger populations have been. Furthermore, the fact that the AHEAD population is almost completely retired means that a very strong confounding effect of health on income via work status is practically eliminated. Finally, almost the entire AHEAD population is covered by Medicare: therefore, an important causal pathway linking SES to mortality via access to health care services is reduced and even possibly eliminated.

The HRS and AHEAD asked respondents to give an estimate of their survival chances to a target age, which was approximately 12 years in the future. In the HRS this variable is a significant predictor of mortality between waves 1 and 2 (Hurd and McGarry, 1997). Here we aim to find if it has predictive power for mortality in the AHEAD population both unconditionally and conditionally on observable characteristics.

In this paper we will verify that SES is related to mortality in the AHEAD data. Then we will give evidence about the validity of the subjective survival probabilities. The evidence will be of three kinds: whether the subjective survival probabilities vary in cross-section in a way that is appropriate given the variation in actual mortality; how the subjective survival probabilities change in panel in response to new information such as the onset of an illness; and whether they predict actual mortality. We will then examine whether, conditional on health status, SES and the subjective survival probabilities have explanatory power for predicting mortality

2. Data

Our data come from the study of the Asset and Health Dynamics among the Oldest-Old (AHEAD).[1] This study is a biennial panel survey of individuals born in 1923 or earlier and their spouses. At baseline in 1993 it surveyed 8222 individuals representative of the community-based population except for oversamples of blacks, Hispanics and Floridians. Wave 2 was fielded in 1995.

The main goal of AHEAD is to provide panel data from the three broad domains of economic status, health and family connections. Our main interest in this paper is to understand the predictors of mortality between waves 1 and 2, especially education, income, wealth and the subjective probability of survival. In wave 1 individuals and couples were asked for a complete inventory of assets and debts and about income sources. Through the use of unfolding brackets, nonresponse to asset values was reduced to levels much lower than would be found in a typical household survey such as the SIPP.[2]

---

[1] See Soldo, Hurd, Rodgers and Wallace, 1997.
[2] To handle non-response to asset and total income questions, we use a nested composite imputation procedure. We impute non-response to asset ownership, unfolding brackets, and asset amounts

Both HRS and AHEAD have innovative questions about subjective probabilities, which request the subject to give the chances of future events. We will use observations on the subjective probability of survival. The form of the question is as follows:

[Using any] "number from 0 to 100 where "0" means that you think there is absolutely no chance and "100" means that you think the event is absolutely sure to happen ... What do you think are the chances that you will live to be at least A,"

where A is the target age. A is 80, 85, 90, 95, or 100 if the age of the respondent was less than 70, 70-74, 75-79, 80-84, 85-89 respectively. The question was not asked of those 90 or over or of proxy respondents.

AHEAD queries about a wide range of health conditions. Many are asked of the respondent in the following form: "Has a doctor ever told you that you have …" We will use information on 10 conditions such as cancer, heart attack/disease and lung disease. The respondent is queried about limitations to activities of daily living (ADL). We will use as an indicator of poor health three or more ADL limitations.

AHEAD measures cognitive status in a battery of questions which aim to test a number of domains of cognition (Herzog and Wallace, 1997). Learning and memory are assessed by immediate and delayed recall from a list of 10 words that were read to the subject. Reasoning, orientation and attention are assessed from Serial 7's, counting backwards by 1 and the naming of public figures, dates and objects.[3] In prior work we have found that unrealistic stated subjective survival probabilities are associated with low cognitive performance (Hurd, McFadden and Gan, 1998). Therefore we aggregated the cognitive measures in AHEAD and formed a categorical variable to indicate low cognitive performance.

AHEAD also has a battery of questions that are extracted from the CESD scale. The scale aims to assess depressed mood. We form an indicator of depressed mood based on these questions.

3. Results

The baseline AHEAD sample was 8222, of which 813 died between waves 1 and 2, and 7364 survived. The vital status of 45 is unknown. Excluding the 45, the two-year mortality rate was 0.099.[4] This mortality rate cannot be compared with any lifetable rate for two reasons: first, the

---

sequentially. Ownership and complete brackets are imputed using stepwise logistic regression on a number of demographic characteristics. Dollar amounts are then imputed, conditional on a complete bracket, using a nearest neighbor which makes extensive use of covariates (Hoynes, Hurd and Chand, 1998).

[3]Serial 7's asks the subject to subtract 7 from 100, and then to continue subtracting 7 from each successive difference for a total of five subtractions.

[4]The mortality rate including the 45 cases among the living was 0.0988. Including them among the dead the mortality rates was 0.104. In the rest of the paper we will include them among the living for

AHEAD baseline is the community-based population, so that it excludes residents of long-term care facilities who have substantially higher mortality rates than the community-based population. Lifetables include residents of long-term care facilities and of other institutions.[5] Second, the AHEAD sample includes spouses of AHEAD age-eligible respondents, but the spouses may themselves not be age-eligible. The age-ineligible spouses do not make up any population whose mortality rate can be compared with a lifetable.

The mortality rate of the AHEAD age-eligible sample (n=7446) was 0.107; the lifetable rate interpolated to 1993 was 0.155. The difference comes from the high mortality rates among the institutionalized.

Table 1 shows weighted mortality rates for the age-eligible part of the AHEAD population by age and sex, and the number of observations. A few respondents were age 69 at their initial interview but we include them in the 70-74 age band. The weights account for the oversamples at baseline. The figures show sharply increasing mortality rates with age and a considerable difference between men and women. At older ages the number of subjects diminishes rapidly due to mortality, cohort effects, and the fact that the institutionalized are not in the AHEAD baseline.

Table 2 presents mean wealth and income by age and marital status. Wealth is the total of housing wealth, financial, business and other real estate wealth, but it does not include any pension wealth. Income includes all financial income such as pension income, but no flow from owner occupied housing. Just as in other cross-section data sets, wealth and income fall with age, and both are higher among couples than among singles. The table makes clear that we cannot study the relationship between mortality and economic status without effectively controlling for age.

Wealth, Income and Education

Table 3 shows average and median wealth in wave 1 by vital status in wave 2. At baseline among single males aged 70-74 who survived to wave 2, average wealth was about $216.5 thousand. Wealth was just $67.2 thousand among those who died. This is, of course, a substantial difference and indicates considerable differential mortality by wealth holdings. The difference among single females is smaller but still substantial. Among married males there is only a small difference, whereas married female survivors had almost twice the wealth on average as deceased married females. The medians also indicate considerable differential mortality by wealth.

There is diminished differential mortality by wealth among those 75-79. Given the amount of observation error on wealth, we judge there to be little difference in wealth holdings by mortality outcome among those married at baseline, either male or female. There is some difference among singles. The differences are smaller still among the 80-84 year-olds, and there are no consistent

---

convenience, but their treatment is not consequential compared with the lack of data on the institutionalized population.

[5]Because AHEAD will follow the baseline respondents into institutions, it will eventually be representative of the entire cohort of 1923 or earlier.

differences among the 85-89 year-olds. The medians show somewhat more differential mortality but not as much as at the youngest age interval.

Among those 90 or over, sample sizes are small. For example, just 39 single males and just twenty married females were in the age interval at baseline. The group with the largest number of observations (single females) shows no differential mortality.

These data are summarized in Figure 1, which shows the wealth of decedents relative to the wealth of survivors.[6] For example, single female decedents aged 70-74 had about 40 percent of the wealth of survivors. The figure shows a general trend to smaller differences in wealth at greater ages. We conclude that overall there is evidence of differential mortality by wealth: on average those who died had about 70% of the wealth of those who survived. However, the difference decreases with age.

Table 4 has comparable results but for average education. Thus, among males age 70-74 the average level of education was 11.5 years among survivors and 10.4 among the deceased. In the first age band the differential is considerable and it is the same for each sex. At ages 75-79 the differential decreases for men but remains about the same for women, and by 80-84 there is no differential among men. It is notable that in the highest age interval, the educational level of women is higher than that of men even though for these cohorts the educational level of a complete population of men would have been considerably higher. An explanation is found in the differential mortality at younger ages: women consistently have a higher mortality gradient by education than men, causing the better educated women to survive at a higher rate than the better educated men.

Tables 5 and 6 show mortality rates by wealth and income quartiles. The quartiles are defined separately by marital status, but the quartile boundaries are the same over the entire age range. Because of the correlations between age and economic status, and between age and mortality, overall mortality varies strongly by wealth or income quartile as shown in the last line of each table. However, this relationship is much less clear when age is controlled for. In the first age band there is a consistent decline across the quartiles, but in the other age bands there is little consistent pattern even though mortality is generally the largest in the first wealth quartile. Mortality by income has a more consistent pattern and for some age intervals the effects are very strong. For example among 80-84 year-olds the morality rate in the lowest income quartile is about 56% greater than in the highest. As with wealth, however, the differential seems to diminish with age.

These figures, particularly for wealth, suggest that differential mortality may decrease with age. To test that idea we estimated analysis-of-variance models where the observations are mortality rates classified by age intervals, and income and wealth quartiles. The models had complete interactions between age intervals and income quartiles and between age intervals and wealth quartiles. We tested for significance of the interactions. We could reject the null hypothesis that the interactions for couples and separately for singles are all zero at the five percent level, but not at the one percent level. Because the age interactions are not particularly strong and in the interest of simplifying the analysis, our basic model will have age effects, and income and wealth quartiles but not interactions. We will leave the exploration of the age interaction for future research.

---

[6] Not shown when the category has less than 100 observations.

Table 7 has mortality rates by education level for males. As the table shows, in the AHEAD data mortality is higher for men with 9-11 years of education than for males of 0-8 years of education, and this is true holding age constant. We have no good reason for this result, except possibly that those with 0-8 years of education have been highly selected by the time they reach the AHEAD ages. Holding age constant, we see some pattern of differential mortality in the younger age bands, but it is less apparent at older ages.

Among females in their 70s there is a strong and consistent relationship between mortality and education, but at older ages there is little if any (Table 8).

Overall we conclude that there is differential mortality by educational attainment at the younger ages in the AHEAD population, but the effects diminish with age. Particularly among females, who comprise most of the observations in the population 80 or over, there is little evidence for a mortality gradient by education.

Subjective Probabilities of Survival

The subjective probability of survival has been studied extensively in data from the HRS (Hurd and McGarry, 1995, 1997). In cross-section it aggregates well to lifetable levels and it varies appropriately with known risk factors. Furthermore, in panel it is a significant predictor of actual mortality even after accounting for SES and a number of disease conditions. In AHEAD baseline it aggregates well to lifetable values among those aged 70-79, but in the older age groups the subjective survival probabilities overstate survival compared with lifetable rates (Hurd, McFadden and Gan, 1998). One cause of the excess survival probability is that a fairly small number of subjects give a probability of 1.0 of surviving to the target age. The propensity to give a probability of 1.0 is related to low cognitive status, and often an individual will give a probability of 1.0 to a number of unrelated subjective probability questions. Such regularities provide evidence of error in some of the responses. Nonetheless we will take the responses as they were given by the AHEAD subjects. We imagine, however, that the predictive power of the subjective survival probabilities could be increased were some of the reporting error removed by application of a model of the error.

Table 9 shows the average subjective survival probability by age band and wealth quartile.[7] It is important to group by age in this manner because all the respondents in each age band were given the same target age. As would be expected the average survival probability declines with age, but unlike actual mortality there is little systematic variation in the survival probability as a function of wealth. For example, among those 70-74 the average subjective survival probability is about the same in the lowest and the third quartiles. Only in the highest quartile is it greater. Yet the actual two-year survival rate was five percentage points higher in the fourth quartile than in the first quartile: Such a large difference in two-year survival should accumulate to a much greater difference in subjective survival to the target age.

---

[7] Both the wealth and income quartiles are calculated separately by marital status.

As shown in tables 10 and 11, there is little variation in the survival probabilities as a function of income quartiles or of education bands.

A possible reason for the lack of any pattern by wealth, income, or education is the rather high rate of nonresponse to the survival probabilities.[8] A substantial number of interviews were by proxy, often because of the frailty of the targeted respondent. In this case it made no sense to ask a proxy about the subject's subjective survival probability. In addition a rather large number of respondents replied "Don't know" (DK) to the query. Table 12 has the counts of nonresponse as a function of wealth quartile. Overall about 25% of singles and 21% of married persons were nonrespondents. It is clear that the rate of nonresponse is greatest among those in the lowest quartiles. For example, among 70-74 year-olds the rate of nonresponse was about 31% in the lowest quartile and 11% in the highest. Furthermore, because the propensity to give a proxy interview and the likelihood of a DK are related to health status, it is probable that the responding sample is systematically selected toward those with higher survival probabilities. Therefore, the averages in the lowest quartiles are higher than the true quartile averages whereas the averages in the highest quartiles are closer to the true averages, acting to reduce any upward trend in the subjective survival probabilities as a function of wealth.

We ask whether the pattern of nonresponse could conceivably be responsible for the lack of pattern in the subjective survival probabilities, even though there is a clear pattern in actual mortality. We illustrate that it could be responsible by assigning a subjective survival probability of zero to the nonresponders. Figure 2 shows the variation in the subjective survival probabilities under that assignment. The probabilities increase in wealth in each age band. These results show that differential nonresponse has a quantitatively important effect on the level and variation in the subjective survival probabilities. In future work we will explore methods for imputing missing values, but for the rest of this paper we will, as appropriate, use categorical variables to account for nonresponse.

Table 13 shows the estimated regressions of the subjective survival probabilities on the wealth and income quartiles, education bands, and other explanatory variables. We control for age and for the varying interval between the interview and the target age by including as a right-hand variable the lifetable survival rate to the target age from the age of the respondent. If respondents reported their subjective survival probability to be the same as the lifetable rate, the coefficient on this variable would be 1.0. The estimated coefficient shows that the age gradient in the subjective survival probability is less than the age gradient in the lifetable rate. This is partly due to the overestimation of subjective survival probabilities among the oldest compared with the lifetable values.

The three sets of SES variables show no systematic pattern, which is the basic finding from the cross-tabulations in tables 9, 10 and 11. Relative to the lifetable, males overstate their survival chances by 0.07. This tendency to over-optimism is also found in the HRS population (Hurd and McGarry, 1995).

The last two columns of Table 13 contain regressions which include controls for health condition. Most of the health conditions are asked of the respondent in the following form: "Has a doctor ever told you that you have …" The exceptions are "low cognitive score," which is a categorical variable indicating a low score on the sum of three items that were administered in the

---

[8] This low response rate in AHEAD is in contrast to the very high response rate in HRS.

survey itself; and "depression," which is based eight items from the CESD (Wallace and Herzog, 1995). A categorical variable for depression indicates a score of five or more on the CESD. Eight of the 13 health variables are significant at the 0.05 level, and they are associated with a reduction in the subjective survival probabilities of nine to 25 percent of the average probability. For example having had a heart attack or heart disease prior to wave 1 is associated with a reduction in the subjective survival probability of 0.062 from a base of 0.415 or about 15 percent. Based on these results we would expect the subjective survival probabilities to predict actual mortality because of their association with the health conditions which, themselves, are associated with mortality.

Change in the subjective survival probabilities

As individuals age the subjective survival probabilities should increase among survivors holding the target age constant. Between waves 1 and 2 the average increase was 0.064 (16 percent) among singles and 0.051 (15 percent) among couples. Tables 14 and 15 show the levels and changes by age band and by sex. The tables show that the subjective survival probabilities are overstated relative to lifetables at older ages, particularly among men. For example among men aged 85-89 the average subjective survival probability to age 100 is 0.314 whereas the average lifetable value is 0.034. In terms of relative risk, the increases in the subjective survival probabilities from wave to wave are reasonably close to the increases in the lifetable probabilities except in the oldest age intervals. Although it is difficult to know what the appropriate standard of comparison is, it is notable that in all age bands the subjective survival probabilities increase between the waves. This increase was not found in HRS: among survivors the average subjective survival probability decreased slightly (Hurd and McGarry, 1997).

Besides increases in the subjective survival probabilities that are due to the AHEAD subjects surviving for two years, the probabilities should change in response to new information that alters survival chances. Such information would be onset of a health condition that is associated with an increased risk of death. Table 16 shows the incidence of new conditions between waves 1 and 2 for all respondents. Thus, for example, among singles who had not had cancer prior to the baseline interview, 5.1 percent had a cancer between the waves. Among all singles, including those with a history of cancer prior to baseline, 5.5% had a new or initial cancer between the waves. Although it is not the focus of this paper the table shows that having a prior history of cancer, stroke, heart attack/disease, hip fracture or fall increases the risk of a new, similar event. Having a low cognitive score, which is associated with increased risk of dementia, has the greatest rate of onset.

About 8.2 percent of singles who were living in the community at wave 1 were in a nursing home at wave 2.

There is little difference in the rates of onset between singles and couples except for limitations on the activities of daily living (ADL limitations) and nursing home entry. The measure of ADL limitations is an indicator for ADL limitations greater than two, and singles had an incidence rate of 10.4% compared with couples of 6.6%. The difference likely comes from the fact that on average singles are older than couples and from the ability of couples to help each other, disguising some mild cases of ADL limitations. As in the case of ADL limitations the rate of entry into a nursing home is

greater among singles because of age differences and because a spouse can provide help that will keep the other spouse in the community.

Table 17 shows the estimated regression of the change in the subjective survival probabilities between waves 1 and 2 on the incidence of health conditions and other events.[9] To the extent that the onset of a new condition provides new information about survival chances, onset should reduce the subjective survival probabilities. A number of the conditions have negative coefficients indicating that onset reduces the subjective survival probabilities, and cancer, high blood pressure, diabetes and depression have negative effects that are significant at the five percent level. The depression indicator is somewhat different from the other health condition indicators in that it probably depends on the same or similar aspects of health as the subjective survival probabilities.[10] The death of a spouse increased the subjective survival probabilities. In the HRS the death of a spouse decreased subjective survival probabilities (Hurd and McGarry, 1997). An explanation for the difference may be that at the ages of the AHEAD respondents the death of a spouse is preceded by a period of care that reduces the optimism of the caregiver.

The onset of ADL limitations of three or more increased subjective survival probabilities. Because there is no obvious reason for this result we performed some estimations with more detail. First, the increase is found in detailed regressions for singles and couples separately. Second, we defined some additional categories for change in ADL limitations and estimated their effects. The categories were: (1) no baseline ADL limitation and one or more ADL limitations in wave 2; (2) one or more ADL limitations in baseline and an increase in limitations by wave 2; (3) one or more ADL limitations in baseline and no increase by wave 2. For category (1), which is onset of any ADL limitation, the effect is to reduce the subjective survival probability by a small amount (-0.014, not significant). For category (2), the effect is to increase the subjective survival probability by 0.054 (p-value of 0.045) and for category (3) it is to increase the subjective survival probability by 0.040 (p-value of 0.109). Thus the increase in the subjective survival probability accompanying the onset of three or more ADL limitations is due to those who had existing baseline ADL limitations reporting higher probabilities in wave 2. We have no explanation for this increase.

Subjective survival probabilities and mortality

As discussed earlier, the rate of response about subjective survival probabilities was rather low in AHEAD, and actual mortality between waves 1 and 2 was above average among the nonresponders. As shown in the last row of Table 18, the overall mortality rate among the 7446 age-eligible subjects in wave 1 was 10.6% The other rows show mortality rates among those who did not answer the question about subjective survival probabilities. These nonrespondents are divided according to reason for nonresponse. The first row shows the mortality rate among those who were age 90 or over at wave 1: by survey design they were not asked the question about subjective survival, and their

---

[9] For heart attack, cancer and stroke, those with a history of the condition at baseline and who had a new incident between waves 1 and 2 are included as incident cases.

[10] The depression indicator takes the value one if the sum of the eight items on the CESD8 is greater than four.

two-year mortality rate was about 0.30. Those who answered DK (do not know) had approximately average mortality rates whereas those who answered RF (refuse to answer) had somewhat elevated mortality rates. A large group (685) were interviewed by proxy in wave 1, and they had a substantially higher mortality rate than average. A main reason for interview by proxy was that the subject was too frail or cognitively impaired to be interviewed. This frailty is reflected in the mortality rate.

Table 19 has mortality rates by subjective survival probability in wave 1. The table shows that the subjective survival probabilities have considerable explanatory power for mortality particularly in the low range. Thus, for example, the mortality rate among those who gave a zero probability of survival was about 0.13 compared with about 0.05 among those that gave a 0.50 probability of survival. The mortality rates are basically flat from the interval 0.21-0.30. This is similar to the relationship found between the subjective survival probabilities and mortality in the HRS (Hurd and McGarry, 1997). The increase in mortality at the two highest probability intervals indicates observation error that is likely related to misunderstanding or cognitive malfunctioning.

More detailed cross-tabulations of the correlates of mortality are not practical, so we turn to data-descriptive probit estimation as a way to reduce the dimensionality of the predictors. Table 20 has the results from probit estimation of the determinants of mortality. The left-hand variable takes the value one if a subject died between the waves and zero otherwise. We control for age and sex by including as a right-hand variable the two-year mortality rate by age and sex from an interpolated 1993 lifetable. Thus the other right-hand variables will show the deviation in mortality rates from the lifetable rate. The probit coefficients have been translated into probability effects via the linear approximation

$$\frac{\P P}{\P x} = bf$$

where b is the probit coefficient on x and f is the normal density evaluated at the average mortality rate of singles.[11]

The table has three sets of results depending on which variables are included.   In each set the first column has the effects and the second the statistic for testing the null hypotheses that the effect is zero. Approximately, a statistic of 2.0 indicates significance at the five percent level.

The first entry in the table is the coefficient on two-year age- and sex-specific mortality rates from a 1993 interpolated lifetable. The coefficient is less than 1.0, reflecting the fact that in AHEAD mortality does not increase with age as rapidly as the lifetable mortality. The difference in mortality is partly due to the increasing fraction of the population that is institutionalized at greater ages. In that this part of the population is missing from AHEAD mortality rates in AHEAD will be progressively lower than mortality rates from a lifetable, which reflect the entire population. An additional factor

---

[11] We will use the word "effects" when we refer to the probability coefficients. We recognize that while they describe systematic relationships in the data they do not necessarily measure causal relationships. It would require considerable more investigation to ascribe causality.

could be that AHEAD is a more accurate measure of current mortality than the lifetables that we use.[12]

In the first column of Table 20 mortality does systematically decrease in wealth in approximately the same way as in the cross-tabulations in Table 5, but the coefficient on just one of the wealth quartiles is significant at the five percent level. Mortality is generally lower in the higher income quartiles. The effect of education is partly obscured by the higher mortality rate in the second education band compared with the first, but moving from the second to the fourth education band reduced mortality by 0.039 (p-value of 0.054).

The mortality rate of men was about 0.022 greater than would be predicted from the lifetable.[13] Married respondents had mortality rates that were about 0.023 lower than singles: this is a substantial reduction amounting to about 21% of average mortality. There was no differential effect of marital status for men compared with women. That is, marriage does not provide additional mortality protection for men relative to women.[14]

The next two columns show the effects when the subjective survival probability is added along with a set of variables to account for missing observations on the subjective survival probability. We entered the subjective survival probability as a deviation from the lifetable survival rate to the target age. We did this because of the varying time interval between the age of the subject and the target age. This formulation also automatically scales for the fact that the effect on two-year mortality of a survival probability to an age 11-15 years in the future will vary with baseline age.

When the subjective survival probability is added, both the wealth and income effects are reduced and they are no longer statistically significant. The effect of education as measured by the difference between the second and fourth bands remains substantial and the difference is significant. The subjective survival probability is itself a powerful predictor of mortality: varying the subjective survival probability from zero to one would reduce two-year mortality risk by 0.079 or 74%. The indicator variable for proxy interview predicts much higher mortality.

The last two columns have probit results when the baseline health conditions are included. Of the 13 health conditions, 10 are significant at the 0.05 level, and each acts to increase mortality risk with the effects varying from 16 to 66 percent. Adding the health variables reduces the effect of the subjective survival probability by 33 percent, but it is still substantial. The effect of a proxy interview is reduced, as would be expected because proxy interviews are often due to poor health. Those with low cognitive status at baseline had elevated mortality rates.[15]

In additional estimations which we do not report here, we estimated separate mortality probit models for males and for females. Our objective was to find if there were substantial differences in

---

[12] To test whether our single lifetable mortality rate was adequately controlling for age we also added in five age intervals (not shown). None was significant and all were small. We conclude that there is no requirement for age indicators when the age- and sex-specific lifetable mortality rates are used.

[13] Separate estimation of the mortality probit by sex shows that the coefficient on "lifetable" is different for male and female.

[14] See Lillard and Waite (1994) for the opposite finding.

[15] We interacted low cognitive status with the subjective survival probability. The interaction did have a positive sign, indicating that among those with low cognitive status the subjective survival probability are less predictive of mortality, but the effect was small and not significant (not shown).

the effects of SES or health conditions on mortality. In general there were few differences: as in the pooled results no income or wealth quartile had a sizable effect nor was any significant. However, the education gradient between the second and fourth age bands, which we found in the pooled estimation, was only found in the results for men. The effect of marital status was somewhat greater for men than for women, reducing the mortality rate by 0.032 compared with 0.015. In terms of relative risk, the reduction in risk for men was 26 percent and for women it was 16 percent. The effects of health conditions were about the same for men and women.

4. Conclusion

We found that, as in other data, mortality is related to SES. The relationship is strong at younger ages in AHEAD and appears to weaken at older ages. Any explanation at this point would be rather speculative, but the finding is consistent with the view that the primary cause of the gradient is unobserved individual characteristics that cause both bad health and therefore early death, and that cause lower earnings and therefore lower wealth and less education. Were the causality primarily to run from economic resources to health and mortality, we should see a persistent difference in mortality outcomes in very old age between those with substantial resources and those with few. We tentatively conclude that we do not see this, although we acknowledge this should be confirmed by further analysis. If the differential is due to unobserved individual differences, the mortality gradient operating at younger ages will have truncated the distribution, so that in extreme old age the variation in individual characteristics would be greatly reduced. Therefore, classifying people by SES would not produce any substantial differences in mortality.

In cross-section the subjective survival probability is related to baseline health conditions, and there is some consistency in the relative importance of the health conditions on the subjective survival probability and in their importance in predicting actual mortality. For example, of the five largest health effects on the subjective survival probability, three are among the five largest predictors of mortality (cancer, lung disease and ADL >2). In panel the subjective survival probability increases among survivors, and the effects of new health conditions on the panel change in the subjective survival probabilities are similar to the cross-section effects of baseline health conditions. For example, of the five largest effects of the onset of health conditions on changes in the subjective survival probability, three are among the five largest cross-section effects (cancer, lung disease and depression).

The subjective survival probability predicts actual mortality as in the HRS, which should increase our confidence that it can be used to construct individualized lifetables for models of life-cycle saving behavior as proposed by Hurd, McFadden and Gan (1998). Whether such lifetables will have substantial explanatory power for saving remains to be determined as more waves of AHEAD become available.

The relationship between SES and mortality that is found in cross-tabulations (as in Table 5) disappears when health status is controlled for as in Table 20. This result suggests that any differential access to health care services related to SES is small. Were that not the case, in a population with homogeneous baseline health (or with effective controls for baseline health status) those with higher

SES would be more likely to receive appropriate treatment for the onset of a severe condition and, therefore, to survive. We do not find such a relationship. There could still be a role for SES, however, through modifications in the probability of the onset of health conditions, which, in turn, would affect mortality risk. To assess that path will require an additional dynamic model of health status.

Table 1
Two-year mortality rates (weighted)

	Male		Female	
	number	mortality rate	number	mortality rate
69-74	1170	0.064	1626	0.058
75-79	820	0.126	1264	0.080
80-84	574	0.164	953	0.104
85-89	268	0.216	468	0.169
90 +	82	0.402	221	0.262
ALL	2914	0.125	4532	0.095

Table 2
Average wealth and income, weighted (thousands)

	Age				
	70-74	75-79	80-84	85-89	90+
			Wealth		
Singles	141.6	113.0	91.4	86.6	77.2
Couples	269.3	243.1	204.7	187.9	86.1
			Income		
Singles	17.0	14.9	13.1	13.4	11.2
Couples	31.8	30.8	29.6	25.8	15.0

Note: For couples "age" is the respondent's age, "wealth" is the wealth of the couple, and "income" is the income of the couple. Thus each couple enters the table twice
Source: Authors' calculations from AHEAD wave 1

Table 3
Wealth at baseline (thousands)

| | All | | Vital status in wave 2 | | | | |
| | | Survived | | | Died | | |
	N	N	Mean	Median	N	Mean	Median
Age 70-74							
Single							
Male	250	228	216.5	69.8	22	67.2	20.4
Female	828	776	128.7	51.7	52	52.9	25.6
Married							
Male	906	854	282.6	150.8	52	268.3	115.6
Female	777	737	260.3	140.6	40	138.6	100.8
Age 75-79							
Single							
Male	204	176	176.7	68.3	28	129.9	96.0
Female	802	737	100.8	44.0	65	75.8	29.5
Married							
Male	606	531	255.3	125.2	75	225.8	103.0
Female	445	410	232.5	117.0	35	214.8	80.0
Age 80-84							
Single							
Male	160	126	111.0	52.0	34	106.0	48.0
Female	704	624	91.4	42.4	80	60.5	25.8
Married							
Male	407	350	212.5	110.7	57	191.4	69.6
Female	244	225	201.2	113.3	19	144.6	95.5
Age 85-89							
Single							
Male	106	84	111.9	35.8	22	75.8	11.0
Female	393	324	82.7	39.0	69	80.0	20.0
Married							
Male	161	125	178.3	74.3	36	135.0	63.2
Female	73	64	225.3	79.0	9	260.2	72.0
Age 90+							
Single							
Male	39	23	205.2	25.9	16	65.7	26.2
Female	199	143	59.0	11.0	56	84.8	26.1
Married							
Male	43	26	97.7	66.5	17	81.9	35.0
Female	20	18	83.4	78.5	2	29.4	47.3

Source: Authors' calculations from AHEAD waves 1 and 2

Table 4
Years of education

	69-74		75-79		80-84		85-89		90+	
	male	female	male	female	male	female	male	female	male	female
Survived	11.5	11.5	11.3	10.9	10.4	10.4	10.0	10.7	8.6	9.2
Died	10.4	10.4	11.1	10.0	10.4	10.2	8.5	10.2	8.1	9.1
number	*1170*	*1626*	*820*	*1264*	*574*	*953*	*268*	*468*	*82*	*221*

Table 5
Two-year Mortality Rates: Wealth Quartiles

	Wealth quartile			
	lowest	2	3	highest
70-74	0.09	0.06	0.06	0.04
75-79	0.12	0.09	0.10	0.09
80-84	0.15	0.13	0.10	0.11
85-89	0.23	0.18	0.16	0.16
90+	0.30	0.29	0.27	0.37
All	0.14	0.11	0.10	0.08

Source: Authors' calculations from the AHEAD.

Table 6
Two-year Mortality Rates: Income Quartiles

	Income quartile			
	lowest	2	3	highest
70-74	0.10	0.05	0.06	0.05
75-79	0.10	0.12	0.08	0.09
80-84	0.14	0.14	0.12	0.09
85-89	0.25	0.17	0.13	0.16
90+	0.31	0.32	0.27	0.28
All	0.14	0.11	0.09	0.08

Source: Authors' calculations from the AHEAD.

Table 7
Two-year mortality rates: education. Males

Age	Education			
	0-8	9-11	12	12+
70-74	0.07	0.11	0.06	0.04
75-79	0.12	0.19	0.08	0.13
80-84	0.15	0.26	0.20	0.11
85-89	0.25	0.28	0.10	0.15
90 +	0.43	0.48	0.42	0.37
ALL	0.14	0.18	0.09	0.09

Table 8
Two-year mortality rates: education. Females

Age	Education			
	0-8	9-11	12	12+
70-74	0.09	0.06	0.05	0.04
75-79	0.11	0.08	0.07	0.06
80-84	0.10	0.11	0.12	0.10
85-89	0.20	0.20	0.14	0.16
90 +	0.25	0.16	0.31	0.28
ALL	0.13	0.10	0.08	0.08

Table 9
Subjective Survival Probabilities: Wealth Quartiles (weighted)

	Wealth quartile			
	Lowest	2	3	Highest
70-74	0.500	0.470	0.509	0.534
75-79	0.382	0.369	0.385	0.403
80-84	0.310	0.310	0.326	0.306
85-89	0.287	0.256	0.317	0.320
All	0.403	0.385	0.422	0.443

Notes: Target ages for survival are 85 for 70-74 age group; 90 for 75-79 age group; 95 for the 80-84 age group; and 100 for the 85-90 age group. Survival probabilities are not asked of persons aged 90 or above.

Source: Authors' calculations from AHEAD wave 1.

19

Table 10
Subjective Survival Probabilities: Income Quartiles (weighted)

	Income quartile			
	Lowest	2	3	Highest
70-74	0.483	0.488	0.492	0.545
75-79	0.348	0.376	0.387	0.415
80-84	0.324	0.331	0.281	0.319
85-89	0.277	0.289	0.333	0.278
All	0.382	0.404	0.410	0.451

Notes: Target ages for survival are 85 for 70-74 age group; 90 for 75-79 age group; 95 for the 80-84 age group; and 100 for the 85-90 age group.   Survival probabilities are not asked of persons aged 90 or above.

Table 11
Subjective Survival Probabilities by Education (weighted)

	Education			
	0-8	9-11	12	> 12
70-74	0.494	0.508	0.491	0.532
75-79	0.341	0.388	0.384	0.417
80-84	0.308	0.338	0.274	0.340
85-89	0.354	0.241	0.308	0.258
All	0.382	0.411	0.413	0.442

Notes: Target ages for survival are 85 for 70-74 age group; 90 for 75-79 age group; 95 for the 80-84 age group; and 100 for the 85-90 age group.   Survival probabilities are not asked of persons aged 90 or above.

Table 12
Subjective Survival Probabilities: Number of nonresponses. All

	Wealth quartile			
	Lowest	2	3	Highest
70-74				
DK	107	51	52	45
RF	16	10	11	3
Proxy	62	47	54	39
Other	1	1	1	0
75-79				
DK	76	57	45	40
RF	17	13	10	15
Proxy	67	48	38	31
Other	0	0	0	1
80-84				
DK	75	44	46	23
RF	22	28	12	5
Proxy	75	44	36	24
Other	1	0	0	1
85-89				
DK	44	18	14	17
RF	10	7	5	5
Proxy	55	18	23	15
Other	0	0	0	0
90+	120	77	62	42
Total Missing	748	463	409	306

Source: Authors' calculations from AHEAD wave 1.

Table 13
Determinants of Subjective Survival Probabilities
Average probability = 0.415

	Coeff	t-stat	Coeff	t-stat
Intercept	0.206	11.819	0.330	14.855
Wealth quartiles				
Lowest	--	--	--	--
Second	-0.028	-2.029	-0.045	-3.247
Third	-0.009	-0.617	-0.030	-2.062
Highest	-0.007	-0.465	-0.030	-1.921
Income quartiles				
Lowest	--	--	--	--
Second	0.020	1.447	0.013	0.988
Third	0.011	0.765	0.000	0.022
Highest	0.033	2.006	0.023	1.382
Years of education				
Education 0-8	--	--	--	--
Education 9-11	-0.001	-0.090	-0.006	-0.417
Education 12	-0.019	-1.369	-0.029	-2.049
Education 12+	0.012	0.828	0.004	0.259
Lifetable survival to target age	0.516	17.796	0.499	17.097
Male	0.072	4.330	0.070	4.253
Married	-0.006	-0.475	-0.020	-1.630
Married male	0.014	0.659	0.017	0.832
Health Conditions				
Heart disease/attack			-0.062	-6.214
Cancer			-0.049	-3.748
Stroke			0.000	0.022
High Blood Pressure			-0.037	-4.037
Diabetes			-0.036	-2.612
Lung Disease			-0.079	-5.665
Arthritis			-0.037	-3.444
Incontinence			-0.020	-1.705
Hip Fracture			-0.044	-1.894
Fall requiring treatment			0.022	1.227
Cognitive impairment			0.018	1.569
ADL limitation (>2)			-0.060	-3.040
Depression (CESD8>4)			-0.103	-6.676
Missing cognition			0.019	0.571
	N=5440	*R-sq=0.06*	*N=5440*	*R-sq=0.10*

Notes: Based on OLS estimation
 Subjective survival probabilities are not asked of persons aged 90 or above.

Table 14
Change in subjective survival probabilities and lifetable rates, wave 1 to 2. Males

	Subjective survival to target age			Lifetable survival to target age		
	Wave 1	Wave 2	Percent change	Wave 1	Wave 2	Percent change
70-74	0.508	0.548	7.9	0.389	0.423	8.7
75-79	0.382	0.470	23.0	0.226	0.259	14.6
80-84	0.332	0.396	19.3	0.098	0.121	23.5
85-89	0.314	0.345	9.9	0.034	0.048	41.2

Notes: Target ages for survival are 85 for 70-74 age group; 90 for 75-79 age group; 95 for the 80-84 age group; and 100 for the 85-90 age group.   Survival probabilities are not asked of persons aged 90 or above. Source: Authors' calculations from AHEAD waves 1 and 2.

Table 15
Change in subjective survival probabilities and lifetable rates, wave 1 to 2. Females

	Subjective survival to target age			Lifetable survival to target age		
	Wave 1	Wave 2	Percent change	Wave 1	Wave 2	Percent change
70-74	0.510	0.558	9.4	0.575	0.605	5.2
75-79	0.388	0.469	20.9	0.399	0.432	8.3
80-84	0.303	0.399	31.7	0.200	0.228	14.0
85-89	0.299	0.376	25.8	0.074	0.091	23.0

Notes: Target ages for survival are 85 for 70-74 age group; 90 for 75-79 age group; 95 for the 80-84 age group; and 100 for the 85-90 age group.   Survival probabilities are not asked of persons aged 90 or above. Source: Authors' calculations from AHEAD waves 1 and 2

Table 16
Incidence of Conditions between AHEAD waves 1 and 2

	Singles (n= 3410)		Married (n= 3496)	
	N at risk	Rate	N at risk	Rate
Onset between waves 1 and 2				
Cancer	2940	5.14	3009	5.08
Cancer - including repeat cancer	3410	5.45	3496	5.78
Stroke	3095	4.78	3214	4.54
Stroke - including repeat stroke	3410	5.81	3496	5.49
Heart attack or disease	2335	10.00	2402	9.00
Heart attack or disease - including repeat attack	3410	13.96	3496	12.04
High blood pressure [1]	1430	12.03	1693	9.27
Diabetes [1]	2621	3.17	2787	2.54
Lung disease	3024	2.91	3113	2.67
Arthritis [1]	2113	17.13	2460	13.74
Incontinence [1]	2355	14.06	2660	12.11
Hip fracture	3190	2.70	3379	1.10
Hip fracture – including repeat fracture	3410	3.05	3496	1.37
Fall requiring treatment	3099	12.62	3278	9.37
Fall requiring treatment - including repeat fall	3410	14.81	3496	10.76
Low cognitive score [2]	1927	29.58	2408	24.29
ADL>2	2969	10.44	3215	6.56
Depression (CESD8) [3]	2667	6.11	2847	4.95
Living in a nursing home wave 2	3410	8.18	3496	3.66
Spouse died	-		3496	7.87

Notes: Sample includes all persons with a wave 1 and a wave 2 interview (including proxy and exit proxy interviews for the deceased).

[1] Condition not asked in exit proxy, incidence may be underestimate, as it includes at risk those who died.

[2] Score of 15 or less on AHEAD cognitive battery questions.

[3] CESD8 score greater than 4; self-respondents only, n=3105 for singles and n=3096 for married.

Table 17
Change in Subjective Survival Probabilities
Average change = 0.057

	Coefficient	t-statistic
Intercept	0.068	6.777
Married	-0.007	-0.483
Male	0.022	1.154
Married male	-0.030	-1.273
Incidence of health conditions		
Heart disease/attack	-0.000	-0.021
Cancer	-0.063	-2.328
Stroke	-0.025	-0.799
High blood pressure	-0.053	-2.249
Diabetes	-0.083	-2.478
Lung disease	-0.066	-1.840
Arthritis	0.016	0.965
Incontinence	-0.020	-1.133
Hip fracture	0.007	0.136
Fall requiring treatment	0.010	0.486
Cognitive impairment	0.004	0.256
ADL Limitation >2	0.067	2.238
Depression	-0.061	-2.504
Spouse died	0.054	2.001
Entered nursing home	-0.017	-0.311
N=4061 R-sq=0.005		

Note: Change in the subjective survival probability is wave 2 report minus wave 1 report.
Incidence of heart attack, cancer and stroke includes new incidents among those with a prior
history. Survival probabilities not asked of persons aged 90 or above.
Source: Authors' calculations from AHEAD waves 1 and 2

Table 18
Two-year mortality rates among non-respondents to subjective survival question

Reason for non-response	mortality rate	number
90+	0.300	303
DK	0.109	765
RF	0.124	194
Other	0.042	24
Proxy	0.244	685
Responders and non-responders	0.106	7446

Source: Authors' calculations from AHEAD waves 1 and 2

Table 19
Two-year mortality rates

Subjective survival probability	Mortality rate	number of observations
0	0.13	1254
1-10	0.10	608
11-20	0.07	218
21-30	0.05	327
31-49	0.06	148
50	0.05	1331
51-70	0.04	224
71-80	0.05	486
81-90	0.04	222
1-99	0.07	41
100	0.05	616

Source: Authors' calculations from AHEAD waves 1 and 2

Table 20
Determinants of Two-year Mortality (*n*=7367)
Average mortality = 0.107

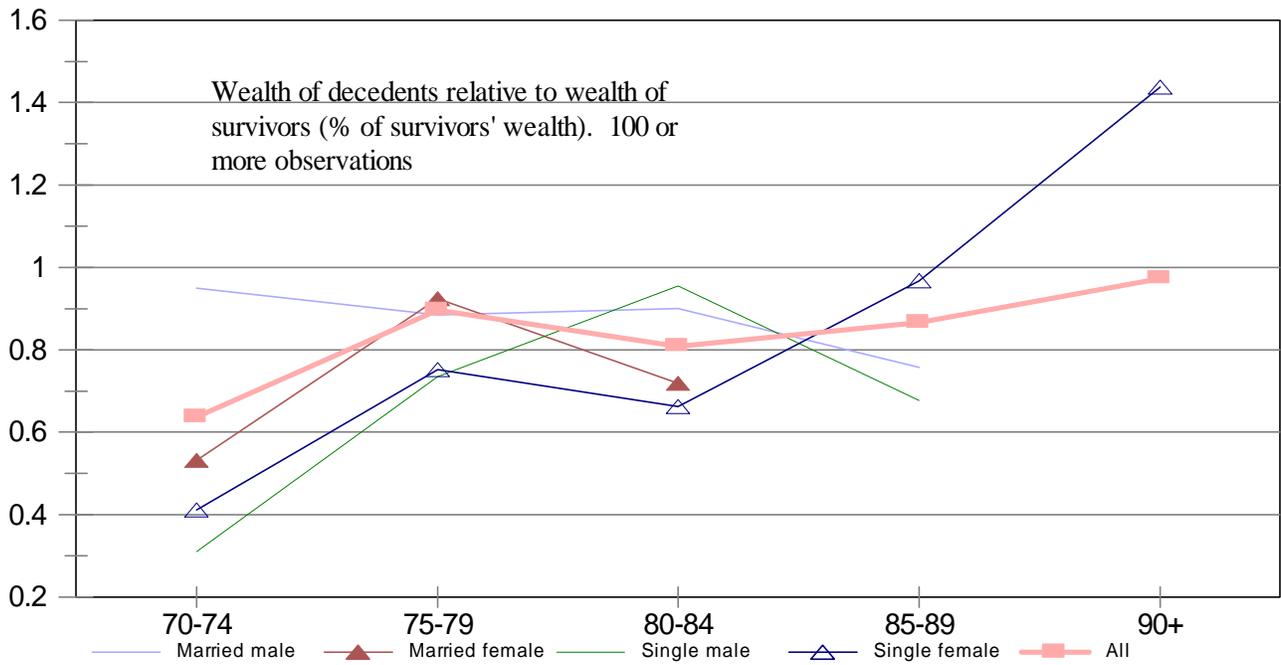|	Effect	Asymp *t*	Effect	Asymp *t*	Effect	Asymp *t*
Intercept	-0.268	22.450	-0.304	22.353	-0.412	23.361
Lifetable mortality	0.566	13.014	0.645	9.979	0.577	8.486
Wealth quartiles						
Lowest	--	--	--	--	--	--
Second	-0.014	1.351	-0.009	0.868	0.004	0.349
Third	-0.017	1.533	-0.013	1.158	0.008	0.670
Highest	-0.026	2.031	-0.022	1.659	-0.001	0.079
Income quartiles						
Lowest	--	--	--	--	--	--
Second	-0.014	1.367	-0.009	0.834	-0.003	0.238
Third	-0.027	2.313	-0.022	1.873	-0.014	1.106
Highest	-0.023	1.698	-0.014	1.070	-0.003	0.203
Education level						
Education 0-8	--	--	--	--	--	--
Education 9-11	0.014	1.313	0.025	2.244	0.034	2.962
Education 12	-0.005	0.468	0.003	0.235	0.020	1.753
Education 12+	-0.017	1.405	0.000	0.006	0.017	1.356
Male	0.022	1.761	0.025	1.928	0.027	2.063
Married	-0.023	2.060	-0.028	2.451	-0.014	1.172
Married male	-0.007	0.422	-0.011	0.656	-0.017	0.978
Subjective survival						
Stated minus lifetable			-0.079	5.693	-0.053	3.693
Missing proxy			0.114	10.118	0.085	6.782
Missing refused			0.028	1.262	0.013	0.528
Missing don't know			0.013	1.031	0.013	0.978
Missing age 90+			-0.014	0.633	-0.009	0.389
Health conditions						
Heart disease/attack					0.028	3.357
Cancer					0.047	4.511
Stroke					0.045	3.695
High blood pressure					0.017	2.132
Diabetes					0.035	3.231
Lung disease					0.071	6.581
Arthritis					-0.014	1.578
Incontinence					-0.003	0.330
Hip fracture					0.038	2.413
Fall requiring treatment					0.000	0.034
Cognitive impairment					0.047	5.109
ADL limitation (>2)					0.070	6.025
Depression (0,1)					0.036	3.010
Missing cognition					0.033	1.492

Note: Based on probit estimation.

Source: Authors' calculations from AHEAD waves 1 and 2

References

Feinstein, J. (1992) "The Relationship between Socioeconomic Status and Health: A Review of the Literature," *The Millbank Quarterly*, 71 (2) pp 279-322

Herzog, R. and R. Wallace (1997) "Measures of Cognitive Functioning in the AHEAD Study," *Journals of Gerontology*, Series B, 52B, 37-48.

Hoynes, Hilary, Michael Hurd and Harish Chand (1998) "Household Wealth of the Elderly under Alternative Imputation Procedures," in *Inquiries in the Economics of Aging*, David Wise, ed., 1998, Chicago: University of Chicago Press, pp. 229-257.

Hurd, M. (1987) "Savings of the Elderly and Desired Bequests," *American Economic Review* 77, 298-312.

Hurd, M., D. McFadden and L. Gan (1998) "Subjective Survival Curves and Life Cycle Behavior," in D. Wise, ed., *Inquiries in the Economics of Aging*, University of Chicago Press.

Hurd, M., D. McFadden, L. Gan, A. Merrill, and M. Roberts (1998) "Consumption and Savings Balances of the Elderly: Experimental Evidence on Survey Response Bias," in D. Wise, ed., *Frontiers in the Economics of Aging*, University of Chicago Press, 353-387.

Hurd, M. and K. McGarry (1995) "Evaluation of the Subjective Probabilities of Survival in the Health and Retirement Survey," *Journal of Human Resources*, 30, S268-292.

Hurd, Michael D. and Kathleen McGarry (1997) "The Predictive Validity of the Subjective Probabilities of Survival in the Health and Retirement Survey," presented at the HRS2 Early Results Workshop, Ann Arbor, 1995, and revised.

Hurd, M. and D. Wise (1989) "Wealth Depletion and Life Cycle Consumption by the Elderly," in D. Wise, ed., *Topics in the Economics of Aging*, University of Chicago Press.

Jianakoplos, N., P. Menchik, and O. Irvine (1989) "Using Panel Data to Assess the Bias in Cross-Sectional Inferences of Life-Cycle Changes in the Level and Composition of Household Wealth," *NBER Research Studies in Income and Wealth*, 52, University of Chicago Press.

Kitagawa, E. and P. Hauser (1973). Differential Mortality in the United States: *A Study in Socioeconomic Epidemiology*, Cambridge, MA: Harvard University Press.

Lillard, Lee and Linda Waite (1994), "Till Death Do Us Part: Marital Disruption and Mortality," *American Journal of Sociology*, 100 (5), 1131-1156.

Shorrocks, A.(1975) "The Age-Wealth Relationship: A Cross-Section and Cohort Analysis," *Review of Economics and Statistics*, 57, 155-163.

Soldo, B., M. Hurd, W. Rodgers and R. Wallace (1997) "Asset and Health Dynamics among the Oldest Old: An Overview of the AHEAD Study," *The Journals of Gerontology*, Series B, 52B, 1-20.

Figure 1
Wealth differences by vital status

Wealth of decedents relative to wealth of
survivors (% of survivors' wealth). 100 or
more observations

Married male — Married female — Single male — Single female — All

Figure 2
Subjective survival probabilites. All

Nonresponses assigned 0

Age

wealth quartiles — 1 qrtl — 2 qrtl — 3 qrtl — 4 qrtl