PERGAMON

Social Science & Medicine 49 (1999) 967–979

SOCIAL SCIENCE & MEDICINE

www.elsevier.com/locate/socscimed

# Subjective life expectancy in the US: correspondence to actuarial estimates by age, sex and race

John Mirowsky*

*Department of Sociology, Ohio State University, 300 Bricker Hall, 190 North Oval Mall, Columbus, OH 43210-1353, USA*

**Abstract**

This study maps the relationship between subjective and actuarial life expectancy in a 1995 national sample of 2037 Americans of ages 18–95. Subjective estimates parallel age-specific actuarial ones based on current age-specific mortality rates. However males expect to live about 3 years longer than the actuarial estimate and blacks expect to live about 6 years longer. The apparent optimism remains after adjusting for socioeconomic status and the signs and symptoms of good health. Contrary to economists' rational-expectations hypothesis, young adults do not adjust their life expectancies upward to account for the favorable trends in mortality rates. © 1999 Elsevier Science Ltd. All rights reserved.

*Keywords:* Life expectancy; Subjective health; Sex; Race; United States

## Introduction

The broad issue addressed in this paper is whether people make reasonably accurate judgments of the remaining number of years of life they can expect. The issue began as a somewhat academic debate among economists over the empirical validity of presumed rational expectations (Lovell, 1986). Economic theories often assume that people have expectations that accurately account for the information available. Any one individual making a particular decision might misjudge, but the errors are essentially random and unbiased with respect to the available information. Subjective life expectancy estimates seem to provide an empirical test of the assumption, because governments regularly disseminate actuarial estimates for public consumption (Hamermesh and Hamermesh, 1983; Hamermesh, 1985; Lovell, 1986).

The issue became political when the state of Hawaii wanted to allow public employees to opt for personally managed retirement accounts (Polluck and Suyderhoud, 1992). Until recently, governments and large corporations in the United States provided large, centrally managed pension programs with defined benefits. In recent decades they began shifting away from that toward individually managed retirement savings accounts with defined contributions. The question arose whether individuals generally will make sensible, rational, informed decisions about saving for retirement. Government and corporate pension plans hire demographers, economists, and investment analysts to plan for the future needs of members. Can government and industry reasonably expect individuals to make decisions for themselves that are, on average, as informed and unbiased as those made by the experts? Again the correspondence between subjective and actuarial life expectancy provides one handle on the issue. It

* Tel.: +1-614-292-6687.

*E-mail address:* mirowsky.1@osu.edu (J. Mirowsky)



PII: S0277-9536(99)00193-8

measures the correspondence between public expectations and expert forecasts about one critical element of planning for retirement, as well as related judgments about things such as the need for medical or long-term care insurance, or the wisdom of enrolling in a comprehensive life care community.

The small number of prior studies consistently find a high correlation between subjective and actuarial estimates of the number of years of life likely remaining, because both depend heavily on current age (Hamermesh and Hamermesh, 1983; Hamermesh, 1985; Polluck and Suyderhoud, 1992). However the difference rather than the correlation is the issue. If everyone guessed the actuarial estimate minus five years the correlation would be perfect but the difference considerable. The United States Bureau of the Census (1995) disseminates actuarial estimates of life expectancy by age, sex and race. Age-specific differences between subjective and actuarial estimates are at the heart of an ongoing debate over whether young adults account for the favorable trends in mortality when making estimates (Hamermesh and Hamermesh, 1983; Hamermesh, 1985; Polluck and Suyderhoud, 1992). Sex and race specific differences may exist, too (Hurd and McGarry, 1995), perhaps owing to beliefs about sex and race specific mortality trends.

The remainder of this introduction reviews the relevant demographic concepts and terms, the prior findings, and the unresolved issues. It also specifies a model that allows tests of several hypotheses, previewed here and explained below. The *age congruity hypothesis* states that age-specific mean subjective life expectancy conforms closely to age-specific actuarial life expectancy, because age has a big effect on both types of estimates. The *cohort-improvement hypothesis* states that younger adults expect longer lives than implied by current age-specific mortality rates, because they expect the mortality rates to be lower when they reach a given age than the rates for people that age now. The *sex-anomaly hypothesis* states that males expect to live longer relative to females than actuarial estimates suggest. The anomaly may exist because men expect larger declines in age-specific mortality than women, because men feel healthier than women despite higher mortality rates, or because men's greater socioeconomic status makes them more confident about survival. The *race-anomaly hypothesis* states that black Americans expect to live longer relative to whites than actuarial estimates suggest. The anomaly may exist because black Americans expect larger declines in age-specific mortality than white Americans, or because the subgroups that account for higher mortality rates among black Americans tend not to participate in surveys.

**Congruity of actuarial and subjective estimates**

Subjective life expectancy measures well-being in terms parallel to core demographic concepts and measures. Demographers define life expectancy as "the average number of years of life remaining to a group of persons reaching a certain age" (Nam, 1994). They do not have a standard term for the sum of current age and remaining life expectancy, but 'longevity' (the length of life) will serve. Whether subjective or actuarial, life expectancy can be defined as follows:

$$\text{life expectancy} \mid \text{age} = \text{longevity} \mid \text{age} - \text{age}. \tag{1}$$

Longevity is the age to which one probably will survive, and life expectancy is the number of years remaining until that age. Actuarial estimates project life expectancy from the age-specific annual survival rates of persons a given age or older (e.g. Nam, 1994; Weeks, 1996). Subjective estimates project from observation, information and intuition. The present survey asks "To what age do you expect to live?" The subjective life expectancy is that imagined longevity minus current age.

Actuarial life expectancy has certain properties that subjective life expectancy inherits. The most obvious is that, for adults, life expectancy goes down as age goes up. This is logically implied in the actuarial estimates for adults because the population has a constrained life span and some of its members die at each age. It is not necessarily true in subjective estimates, but individuals seem to imagine a length of life that appears reasonable for people like themselves (Nelson and Honnold, 1980; Hamermesh and Hamermesh, 1983; Robbins, 1988a). Their beliefs may form by observing the ages at death of people like themselves – particularly relatives (Nelson and Honnold, 1980; Robbins, 1988a; Hurd and McGarry, 1995), or by learning the actuarial estimates or cultural standards (Nam and Harrington, 1986), and then adjusting up or down to account for personal circumstances (Hurd and McGarry, 1995). Knowledge, whether personal, cultural, or scientific, tends to cap the longevity estimate. Subjective life expectancy reflects the understanding that life is limited and gets shorter as one ages.

Actuarial life expectancy has another property that is less obvious but also likely to find reflection in subjective estimates. Actuarial life expectancy goes down by less than one year for each additional year of life lived (Polluck and Suyderhoud, 1992). Another way of saying this is that the longevity expected increases with age. There are two reasons. First, by definition life expectancy must be positive for all persons still alive. One's longevity must be greater than one's current age. Second, the people who survive longer into old age may have been healthier throughout life than average

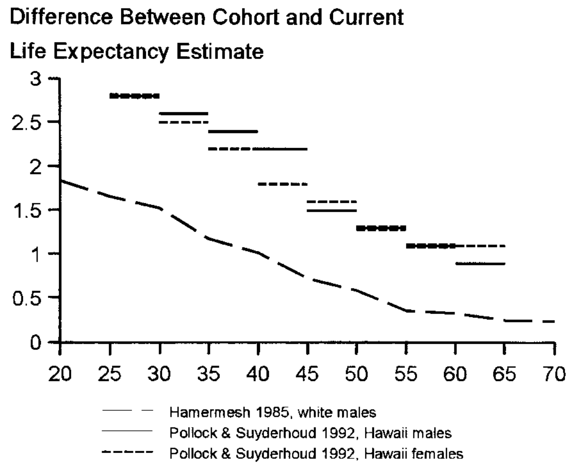


Fig. 1. Actuarial life expectancy estimates based on projected declines in mortality rates for one's cohort exceed the estimates based on current mortality rates by an amount that decreases with age.

for their birth cohort as a whole, and thus always may have expected longer lives.

## Age, sex and race deviations

Because United States life tables provide standard expectations by age, sex, and race it is possible to measure the deviation of subjective expectations from those standard projections. It is useful to define a class of models that adjust for the actuarial expectation in predicting the subjective. Eq. (2) represents the effect of sex, race and age on subjective life expectancy $\lambda_S$ net of the actuarial estimate $\lambda_A$. (Age is centered on 45 so that the intercept represents the predicted difference at that age, which is close to the mean in most random samples of American adults.)

$$\lambda_S = \lambda_A + a_0 + a_1\text{male} + a_2\text{black} + a_3(\text{age} - 45) + u_{\lambda_S}. \quad (2)$$

Eq. (3) rearranges Eq. (2) to predict the difference between subjective and actuarial life expectancy

$$d_{S-A} = \lambda_S - \lambda_A = a_0 + a_1\text{male} + a_2\text{black} + a_3(\text{age} - 45) + u_{d_{S-A}}. \quad (3)$$

### *Cohort improvement*

Coefficient $a_3$ in Eq. (3) describes the effect of age on the deviation between subjective and actuarial life expectancy. Some economists expect that coefficient to be negative, but others disagree. For some labor economists one test of the rational expectation hypothesis hinges on whether subjective judgments follow 'current' or 'cohort' actuarial life expectancies (Hamermesh, 1985; Lovell, 1986; Polluck and Suyderhoud, 1992). By definition a current life table projects from current mortality rates of persons of each age. A cohort table projects from the mortality rates expected if past trends in age-specific mortality continue (Polluck and Suyderhoud, 1992). The actuarial life expectancies circulated for public consumption typically use current-table estimates (e.g. Consumer's Union, 1995; US Bureau of the Census, 1995). Hamermesh (1985) argues that life tables based on current mortality rates ignore the long-term downward trend in age-specific mortality and thus fail to represent improvements that the public expects. Fig. 1 shows the difference between cohort and current estimates using two methods for extrapolating future mortality rates. The younger the age-group the greater the gap between cohort and current estimates of life expectancy.

The economists agree among themselves that rational expectations *should* mimic the cohort life expectancies. Hamermesh (1985) claims the public is rational in this sense; Polluck and Suyderhoud (1992) claim it is not. Hamermesh bases his claim on a mailed survey of white male academic economists and a similar one of white males listed in a local phone book. Based on his analyses, he says that, "People do extrapolate past improvements in longevity when they determine their subjective horizons..." (Hamermesh, 1985, p. 389). It is difficult to find the basis for this claim in his results. The subjective life expectancies reported by economists show no significant effect of the difference between cohort and current actuarial estimates for persons their age ($t = 0.93$, column 7 of Table IV, p. 399), although the coefficient has the proper sign. The expectancies of the phone book sample support the hypothesis even less ($t = -0.17$, column 14 of Table IV). If academic economists lack this particular form of rationality, what of the general public? Polluck and Suyderhoud (1992) suggest that when the state of Hawaii allowed public employees in the professional and teaching unions to opt out of the mandatory retirement system those employees based decisions on systematic underestimates of cohort life expectancy.

Subjective life expectancies that account for declining mortality should exceed the standard estimates based on current mortality by an amount that decreases with age, as implied by Fig. 1. Thus, $a_3$ in Eq. (3) may represent the subjective adjustment for the cohort trends in life expectancy. As noted above, Hamermesh (1985) implies that $a_3$ will be negative, just as the slopes of the lines in Fig. 1 are negative. In other words, younger adults will expect to live longer than the current tables suggest because of the favorable trends in mortality. Polluck and Suyderhoud (1992), who are skeptical about rational expectations, imply that the coefficient will not be negative.

*Sex and race anomalies*

Whether or not age affects the gap between subjective and actuarial estimates, groups defined by sex and race may have subjective expectations that appear optimistic or pessimistic relative to the actuarial projections. Standard life tables for the population of the United States project a life expectancy longer for females than for males of the same age, and longer for whites than for blacks of the same age (US Census, 1995). For example, at age 45 the current actuarial life expectancy is 36.5 years remaining for white females, 32.7 for black females, 31.5 for white males and 26.7 for black males. Clearly the current age-specific mortality rates suggest a shorter future for men than for women of the same age, and a shorter future for blacks than for whites. Do men and blacks adjust their subjective life expectancies accordingly? Perhaps not.

Several studies suggest that men expect to live longer than current-table actuarial estimates suggest. Three studies of death anxiety among college students asked the students how long they expect to live (Handel, 1969; Robbins, 1988b; Joubert, 1992). The samples are small and unrepresentative, but all three find that male and female students expect almost the same longevity. Compared to current table actuarial estimates, the females guess a year or two under and males five or six years over. Two large-scale economic surveys report results that appear to confirm the sex anomaly. The survey of 1111 public employees in Hawaiian teaching and professional unions mentioned earlier finds that the longevities expected by the men are within a year or two of those expected by the women (Polluck and Suyderhoud, 1992), which is much smaller than the gap in actuarial expectations. The Health and Retirement study of American adults born in 1931–1941 and of ages 51–61 when first interviewed asked men and women to estimate the probability they would live to age 75 and to age 85 (Hurd and McGarry, 1995). The men's subjective odds of survival to age 85 are 1.8× greater than the actuarial estimates. In contrast the women's subjective odds of survival to age 75 are two-thirds of their actuarial odds. Thus both psychological and economic research suggests that men may expect longer lives than current-table actuarial estimates suggest, particularly relative to women. The studies all imply that $a_1 > 0$ in Eq. (3).

Two factors could account for a sex anomaly in subjective life expectancy if it exists. First, men may expect more favorable trends in age-specific mortality rates than women expect, because men's mortality rates are higher and thus have more room for improvement. Young men implicitly may expect age-specific mortality rates in the future more like those of women today. If so then the negative effect of age on the difference between subjective and current-table actuarial life expectancy may be greater for men than for women.

The second possible explanation of a sex anomaly is that better current health or higher socioeconomic status lead men to expect longer lives than the actuarial estimates suggest. Men feel healthier than women and have fewer symptoms, impairments, and diagnosed chronic diseases until old age, despite the fact that women live longer (Ross and Bird, 1994). Having fewer symptoms and signs of poor health may give men an optimistic view of their life expectancies. Men also have higher average levels of education, household income, personal earnings and occupational status, and less frequent economic hardship than women, which also might give them an optimistic view of their life expectancies (Ross and Bird, 1994). Analyzing data from the Health and Retirement Study, Hurd and McGarry (1995) find that adjustment for health and socioeconomic status decreases men's subjective probability of surviving to age 75 or 85 compared to women's. On the whole men's subjective probabilities are only slightly lower than women's (although higher than men's actuarial probabilities), but adjustment for socioeconomic and health status significantly increases the gap.

*Hypothetical race anomaly*

Blacks also may expect longer lives than implied by actuarial estimates based on current mortality rates. The suggestion comes from the Health and Retirement study mentioned above of Americans aged 51–61 (Hurd and McGarry, 1995). The subjective odds of surviving to age 75 are 1.1× greater for the blacks in the sample than for the whites, and the subjective odds of surviving to age 85 are 1.3× greater, despite the fact that the actuarial odds of survival are lower for blacks than for whites, although only one survey, the scale and quality of the Health and Retirement Study (Juster and Suzman, 1995), provides a reasonable basis for hypothesizing a race anomaly in subjective life expectancy.

A race anomaly could exist because blacks expect more favorable trends in age-specific mortality than do whites. Younger blacks might reasonably expect far better age specific mortality rates when they get older than exist among older blacks now. If younger blacks expect a convergence of black and white longevity then race will interact with age in its effect on the gap between subjective and current-table actuarial estimates.

A second possible explanation of a race anomaly is that the socioeconomic or health factors that account for higher mortality rates among blacks also reduce participation in surveys. For example, participation in surveys increases with education (Goyder, 1987; Groves, 1990). As a consequence, the race difference in education tends to be smaller in samples than in the population. Suppose that education mediates the effect of race on subjective life expectancy. If so then the sample has a smaller race difference in education than the population so it also has a smaller race difference in subjective life expectancy. The race difference in actuarial life expectancy is the same in the sample as in the population. Thus subjective life expectancy exceeds actuarial more for the blacks in the sample than for the whites. Adjustment for the proximate causes of non-participation that also affect subjective life expectancy will eliminate such apparent anomalies (Winship and Radbill, 1994). Without interviewing the people who did not participate in the survey it is not possible to know if socioeconomic or health factors actually influenced participation. *If* they did then models that adjust for those factors will have unbiased coefficients.

## Methods

### *Sample*

The 1995 survey of *Aging, Status and the Sense of Control* (ASOC) is a national telephone probability sample of United States households. Respondents were selected using a pre-screened random-digit dialing method that increases the hit rate and decreases standard errors compared to the standard Mitofsky–Waksberg method while producing a sample with the same demographic profile (Waksberg, 1978; Lund and Wright, 1994). The ASOC survey has two subsamples, designed to produce an 80% over-sample of persons aged 60 or older. The general sample draws from all households; the oversample draws only from households with one or more seniors. In the general sample the adult (18 or older) with the most recent birthday was selected as respondent. In the oversample the senior (60 or older) with the most recent birthday was selected. For practical reasons the survey was limited to English-speaking adults. Up to 10 call-backs were made to select and contact a respondent, and up to 10 to complete the interview once contact was made. Interviews were completed with 71.6% of the eligible persons who were contacted: 73.0% for the general sample and 67.3% for the oversample. The full sample has 2592 respondents. From that number 2411 identified themselves either as white or black, 2037 answered the question about longevity and 1900 both answered the question and identified themselves as white or black.

The following statistics compare the demographic characteristics of the ASOC sample to those for the US population as a whole (US Bureau of the Census, 1995). These statistics are weighted to compensate for the oversample of seniors. For ASOC and the US, respectively, the percentage female is 56.2 and 51.2, the percentage white is 85.1 and 82.9, the percentage married (excluding cohabitors and the separated) is 55.7 and 55 and the mean household size is 2.67 and 2.59. For persons age 25 or older the percentage with a high school degree is 85.1 and 80.9 and the percentage with a college degree is 25.6 and 22.2. The mean household income is US$43,949 and 41,285.

Although broadly representative, the sample differs in some ways from the population of American adults on whom the actuarial life expectancies are based. Some of the differences are built into the sampling procedure, such as the oversampling of persons older than 59, the exclusion of persons not in households, or the higher probability of getting selected for interview if in a smaller household. Some differences result from well-known patterns of survey participation, such as the lower fractions of males and blacks typically found in samples than in the population. Other differences may result from factors that affect both participation and subjective life expectancy, such as economic marginality, disability, or chronic disease. Rather than weight the sample by the inverse probability of selection, the regression analyses will adjust for variables that account for deliberate or inadvertent differences between the sample and the population. Winship and Radbill (1994) show that such adjustment produces unbiased regression estimates with smaller standard errors than ones based on weighted samples. More importantly, comparing the coefficients of sex, race and age before and after the adjustments will indicate the extent to which sample composition accounts for apparent anomalies.

It is important to note that any differences between the sample and the population in their sex, race and age composition cannot create apparent anomalies. The reason is that actuarial life expectancies are assigned based on each individual's sex, race and age combined, as detailed below.

### *Variables*

#### *Life expectancy*

Actuarial life expectancy comes from Table 116 of the *Statistical Abstract of the United States 1995* (United States Bureau of the Census, 1995), which presents life expectancy based on the mortality rates in 1992. The age-specific actuarial values for white females, black females, white males, and black males are interpolated using a third-order polynomial regression of the Census table values on age that fits with an $R^2$ greater than 0.999 each group and shows little distortion when graphed against the table values. Subjective life expectancy is measured by asking respondents, "To what age do you expect to live?" and subtracting age at the time of the interview from the expected longevity.

*Sex, race and age*

The sex of the respondent was coded by the interviewer at the end of the interview. Race is the respondent's response to the question, "Are you white, black, Asian or Pacific Islander, native American or Alaskan native, or something else?" The analyses below are limited to respondents who identified themselves as black or white. Age is measured by asking the year of birth and subtracting the year of the interview.

*Hazard of not reporting subjective longevity*

Of the 2411 white or black respondents in the sample, 78.8% estimated a personal longevity (1900) and 21.2% did not (511). This raises the possibility that some effects may be understated or overstated because of differential non-reporting. The regression table checks the sensitivity of results by adjusting for the hazard of not reporting subjective longevity (Heckman, 1979; Berk and Ray, 1982). The hazard score represents the predicted risk of not having estimated a personal longevity. Technically it equals the ratio of the probability density at $Z$ to the cumulative probability at $Z$, where $Z$ is the tendency to answer the question predicted from a probit regression. The predicted probit is transformed to a probability, which is then transformed to a hazard score and adjusted in the OLS regressions (see the Analysis Section for details). The Results Section describes the probit model, which is given in Table 2. In theory, adjustment for the hazard adjusts for individual differences in the inclination to estimate longevity.

*Possible mediators*

The final regressions adjust for a large number of variables that might account for observed anomalies. The *socioeconomic variables* include education, parents' education if known, whether or not parents' education is known, employment status (part time, retired, unemployed or laid off, in school, keeping house, unable to work due to disability compared to full time), current or most recent occupation's Census Bureau status score (based on mean education and income in the occupation) and Labor Department assessment of demand for work with data, people, or things, economic hardship in the past year (not enough money to pay the bills, to buy food, clothing or other household necessities, to pay for needed medicine or medical care), household income, the logged ratio of household income to the Federal poverty line, and medical insurance coverage. *Family and household variables* include marital status (single, divorced or separated, widowed, or cohabiting compared to married), the number of children in the household, the number of adults in the household, and whether or not one's parents divorced when one was growing up, a parent died when one was growing up, one's same-sex parent is still alive, and one's opposite-sex parent is still alive. *Health lifestyle variable*s include the number of miles walked per week, the weekly frequency of moderate and of strenuous exercise, the frequencies of eating meat, salty snacks such as potato chips, and sweets, body weight relative to height (weight in kilograms divided by height in centimeters squared) linear and quadratic terms, a dummy variable for obesity (relative weight index greater than 27), current smoking, past smoking, abstention from alcohol, and heavy drinking. *Health variables* include self-assessed health, the number of days in the past week one felt energetic and fit, an index of aches and pains, indexes of sensory and musculoskeletal impairment (Nagi, 1976; McDowell and Newell, 1987), hospitalization in the past year, number of doctor visits in the past year, one's current number of prescribed medications, and an index counting the most common chronic diseases that threaten survival, function, and quality of life (Verbrugge, 1986; Kochanek and Hudson, 1995): heart disease, high blood pressure, lung disease like emphysema or lung cancer, breast cancer, any other type of cancer, diabetes, arthritis or rheumatism, osteoporosis (brittle bones), and ulcers, ulcerative colitis or other digestive problems. The regression adjusts for the entire block of variables.

*Possible predictors of reporting subjective life expectancy*

All the possible mediators also are candidates in a stepwise probit regression predicting the probability of reporting a subjective life expectancy. So are sex, race, age and the product terms for sex and race by age. In addition, several psychological indexes are considered as possible predictors of reporting, including measures of depression, anxiety, anger, distrust, perceived social support and perceived control of one's own life.

Table 1
Means by sex and race for the total sample (T) and for the subgroup (S) that reported subjective longevity: United States, 1995

| | White females | | Black females | | White males | | Black males | |
|---|---|---|---|---|---|---|---|---|
| | T | S | T | S | T | S | T | S |
| Age | 54.556 | 51.161 | 48.818 | 42.136 | 51.148 | 49.332 | 44.540 | 41.651 |
| Actuarial life exp. | 29.003 | 31.785 | 30.937 | 36.068 | 27.243 | 28.649 | 28.042 | 29.902 |
| Subjective life exp. | | 31.074 | | 39.958 | | 31.807 | | 40.250 |
| Actuarial longevity | 83.559 | 82.936 | 79.755 | 78.204 | 78.391 | 77.981 | 72.582 | 71.553 |
| Subjective longevity | | 82.235 | | 82.094 | | 81.139 | | 81.901 |
| Subjective−actuarial | | −0.701 | | 3.890 | | 3.158 | | 10.348 |
| Education in years | 13.088 | 13.415 | 12.525 | 13.582 | 13.628 | 13.812 | 12.576 | 13.125 |
| Parents' education | 10.911 | 11.134 | 10.557 | 11.369 | 11.206 | 11.408 | 10.942 | 10.900 |
| Don't know parents' education | 0.247 | 0.193 | 0.351 | 0.215 | 0.198 | 0.165 | 0.362 | 0.255 |
| Employed full time | 0.318 | 0.364 | 0.422 | 0.472 | 0.543 | 0.571 | 0.585 | 0.674 |
| Income (US$k) | 39.671 | 42.029 | 30.778 | 33.487 | 49.272 | 51.157 | 33.256 | 36.135 |
| Income below poverty | 0.114 | 0.108 | 0.240 | 0.194 | 0.070 | 0.058 | 0.139 | 0.082 |
| Married or cohabiting | 0.537 | 0.571 | 0.289 | 0.319 | 0.661 | 0.667 | 0.462 | 0.388 |
| Children in household | 0.562 | 0.661 | 0.803 | 1.000 | 0.622 | 0.553 | 0.774 | 0.731 |
| Strenuous exercise (d/wk) | 0.959 | 1.086 | 0.766 | 0.841 | 1.428 | 1.528 | 1.962 | 2.408 |
| Body mass index (kg/m$^2$) | 24.878 | 24.784 | 27.006 | 26.813 | 26.272 | 26.326 | 26.607 | 27.095 |
| Count of diagnoses | 1.118 | 0.978 | 1.198 | 0.931 | 0.910 | 0.842 | 0.662 | 0.592 |
| Sense of control | 0.602 | 0.652 | 0.492 | 0.625 | 0.734 | 0.775 | 0.539 | 0.570 |

*Analyses and models*

The analysis has two parts. The first describes the basic relationship between subjective and actuarial life expectancy. It plots the mean subjective estimate by age and compares it to the age-specific actuarial estimate. It describes the correlation between subjective and actuarial estimates. Finally, it compares the mean subjective and actuarial estimates within each race-by-sex group and describes the mean difference for the total sample and for each subpopulation.

The second part of the analysis tests the hypothetical cohort, sex, and race anomalies as well as several possible explanations of them if they exist. The analysis consists of five regression models described below.

Model 1a shown in Eq. (4) measures and tests the three hypothetical anomalies,

$$\hat{d}_{\mathrm{S-A}} = a_0 + a_1\mathrm{male} + a_2\mathrm{black} + a_3(\mathrm{age} - 45). \tag{4}$$

Model 2a shown in Eq. (5) tests the hypothesis that males and blacks expect to live longer than the current-table actuarial estimates suggest because the younger males and blacks expect larger declines in mortality rates than do women or whites. If that is true then the negative effect of age, which represents the cohort anomaly, will be larger for males than for females and larger for blacks than for whites

$$\hat{d}_{\mathrm{S-A}} = (a_0 + a_1\mathrm{male} + a_2\mathrm{black}) + (a_3 + a_4\mathrm{male} + a_5\mathrm{black})(\mathrm{age} - 45). \tag{5}$$

Models 1b and 2b parallel models 1a and 2a but adjust for the possibility that one or more of the anomalies exists because of a residual covariance net of age, sex, and race between the willingness to report a subjective life expectancy and the gap between subjective and actuarial life expectancy. Adjusting for the hazard function $h(Z)$ in effect adjusts for that covariance if it exists (Winship and Mare, 1992; Breen, 1996). In the hazard function (shown in Eq. (7)), $Z$ is the standard normal deviation corresponding to the predicted probability of reporting a subjective life expectancy (shown in Eq. (6)), $\phi(Z)$ is the probability density of the normal curve at $Z$, and $\Phi(Z)$ is the cumulative probability at $Z$. The function represents the slope of the probability of reporting as a fraction of the probability, or the hazard of not reporting subjective longevity. Eq. (8) shows model 2b. The regression coefficient $a_6$ of the hazard function represents the residual covariance between the tendency to answer the question and the gap between subjective and actuarial life expectancy, partialing out any effects of sex, race, and age,

Table 2
Probit regression[a] predicting the tendency to report subjective life expectancy (unstandardized coefficients with $t$-values): United States, 1995. $^{+}p < 0.100$, $^{*}p < 0.050$, $^{**}p < 0.010$, $^{***}p < 0.001$

| | Regression coefficient | Coefficient/standard error |
|---|---|---|
| Black | −0.509*** | −4.572 |
| Age−45 | −0.018*** | −7.349 |
| (Age−45) × male | 0.006* | 2.022 |
| Parents' education | 0.019+ | 1.715 |
| Don't know parents' education | −0.426*** | −5.073 |
| Education | 0.059*** | 4.498 |
| Number of children in household | 0.092* | 2.176 |
| Weekly frequency of strenuous exercise | 0.029+ | 1.770 |
| Body mass index (kg/m$^2$) | 0.015* | 2.094 |
| Sense of control over own life | 0.198** | 2.962 |
| Intercept | −0.373 | −1.379 |
| Pseudo $R^2$ | 0.149 | |

[a] The probit model includes all of the variables described in the methods section that have direct effects significant at $p \geqslant 0.100$ (2-tailed, forward stepwise inclusion).

$$Z = (b_0 + b_1\text{male} + b_2\text{black}) + (b_3 + b_4\text{male} + b_5\text{black})(\text{age} - 45) + \sum_{i=6}^{k} b_i X_i, \quad (6)$$

$$h(Z) = \phi(Z)/\Phi(Z), \quad (7)$$

$$\hat{d}_{\text{S-A}} = (a_0 + a_1\text{male} + a_2\text{black}) + (a_3 + a_4\text{male} + a_5\text{black})(\text{age} - 45) + a_6 h(Z). \quad (8)$$

Model 3 shown in Eq. (9) adjusts for the signs and symptoms that might encourage men, blacks, or younger adults to expect longer lives than actuarial predictions suggest, or that might discourage participation by the persons who account for the higher mor-

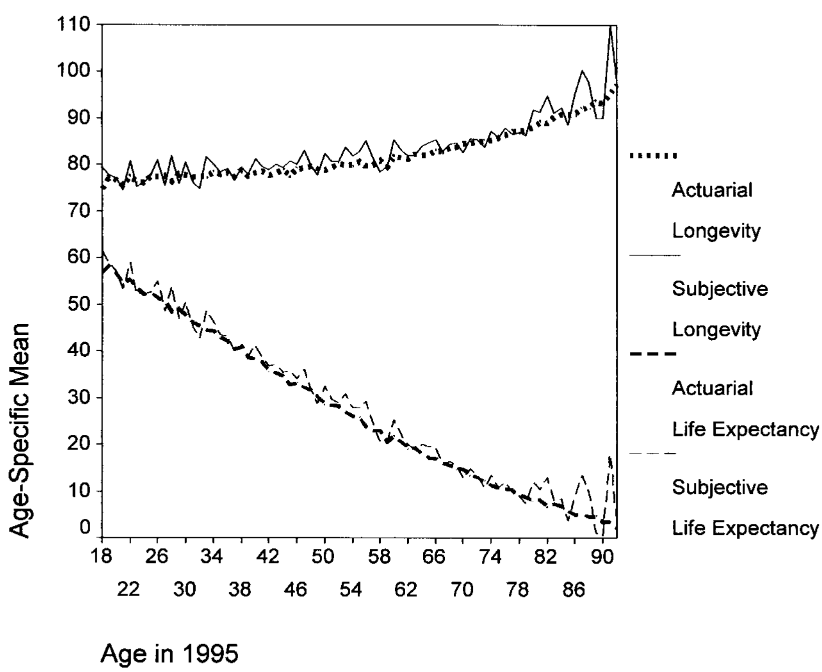


Fig. 2. Mean subjective and actuarial longevity and life expectancy by age, US 1995.

Table 3
Regressions[a] of the difference between subjective[b] life expectancy and the actuarial[c] life expectancy for one's sex, race and age (unstandardized coefficients with $t$-values below): United States, 1995. $^{+}p < 0.100$, $^{*}p < 0.050$, $^{**}p < 0.010$, $^{***}p < 0.001$

| | Model 1a | Model 1b | Model 2a | Model 2b | Model 3 |
|---|---|---|---|---|---|
| Male | 3.747*** | 3.235*** | 3.647*** | 3.372*** | 3.421*** |
| | (7.133) | (6.263) | (6.914) | (6.898) | (5.181) |
| Black | 5.793*** | 7.607*** | 5.542*** | 7.507*** | 6.053*** |
| | (5.544) | (6.843) | (5.263) | (6.625) | (4.023) |
| Age−45 | 0.018 | 0.092*** | 0.023 | 0.116*** | 0.171*** |
| | (1.257) | (4.297) | (1.188) | (4.210) | (3.425) |
| Male × (age−45) | | | 0.000 | −0.035 | −0.012 |
| | | | (0.031) | (−1.177) | (−0.325) |
| Black × (age−45) | | | −0.091 | −0.078 | −0.107+ |
| | | | (−1.488) | (−1.281) | (−1.662) |
| $h(Z)$[d] | | −8.510*** | | −8.975*** | −1.911 |
| | | (−4.600) | | (−4.684) | (−0.360) |
| $a_0$ | −0.856* | 1.453* | −0.884* | 1.471* | – |
| | (−2.423) | (2.370) | (−2.451) | (2.381) | |
| $R^2$ | 0.041 | 0.051 | 0.042 | 0.053 | 0.142 |

[a] Models 1, 2 and 3 regress progressively on sex, race and age (model 1), the interaction of sex and race with age (model 2), and possible mediators of anomalous subjective expectations (model 3), listed in the methods section, that might influence judgments about life expectancy or distinguish the sample's composition from the population's. Models 1b and 2b adjust for the Hazard of not reporting subjective longevity, as described in the methods section.

[b] Respondents were asked, "To what age do you expect to live?". The answer minus current age is the subjective life expectancy.

[c] Actuarial estimates based on current mortality rates by sex, race, and age.

[d] The hazard of not answering the life expectancy question, as defined in the methods section.

tality rates among men or blacks. Factors such as subjective health, fitness, impairment, chronic conditions, personal habits, social or economic resources, parental survival and so on may affect subjective expectations for survival or they may regulate survey participation. In either case, to the extent those factors account for the anomalies then adjusting for them will attenuate the coefficients that represent the anomalies.

$$\hat{d}_{\mathrm{S-A}} = (a_0 + a_1\mathrm{male} + a_2\mathrm{black}) + (a_3 + a_4\mathrm{male} + a_5\mathrm{black})(\mathrm{age} - 45) + a_6 h(Z) + \sum_{i=7}^{k} a_i X_i. \tag{9}$$

## Results

### *Reporting subjective life expectancy*

Table 1 compares attributes of the total sample (T) to those of the subsample (S) that answered the question about longevity. The table shows unweighted means for a select set of variables that illustrate the main differences between the subsample and the total sample. The means suggests that, compared to the total sample, people who report subjective longevity are somewhat younger, had parents who were better educated, are more likely to work full time, have higher household income, are less likely to be poor by Census Bureau definitions, are more likely to be married or cohabiting, have more children in the household, and appear to be healthier and feel more in control of their own lives. However mean differences across race and sex categories appear roughly similar in total and subsamples.

The probit equation in Table 2 shows that the probability of answering the question decreases with age, particularly for women. The probit model includes all of the variables described in the methods section that have direct effects significant at $p \geqslant 100$, 2-tailed, in a forward stepwise regression. The hazard score based on the probit equation in Table 2 correlates 0.718 with age. Thus directly or indirectly age accounts for 51.6% of the variance in the hazard of not responding to the question.

### *Age congruity*

Age-specific means show a broad congruity between aggregate subjective and actuarial estimates of life expectancy. Differences across age groups in mean subjective longevity and life expectancy track the

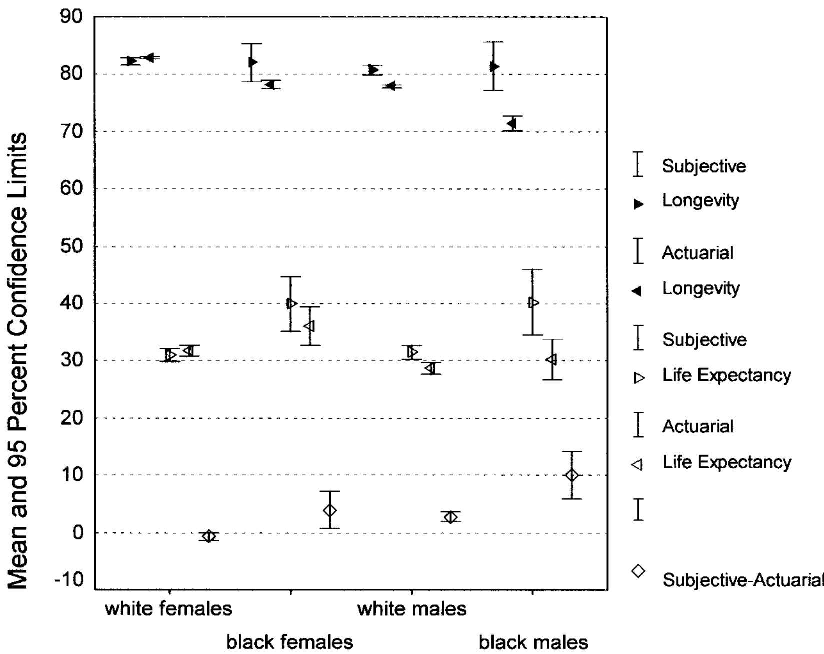


Fig. 3. Mean subjective and actuarial estimates of longevity and life expectancy, and the mean difference, by race and sex, US 1995.

corresponding actuarial estimates well, as shown in Fig. 2. The correlation between the actuarial and subjective estimates is 0.790, which means they have 62.4% of their variance in common.

Large effects of age on both the actuarial and subjective life expectancies appear to account for most of their correspondence. Age correlates −0.981 with actuarial life expectancy and −0.796 with subjective life expectancy. Thus age explains 96.2% of the variance in the actuarial estimates and 63.5% of the variance in subjective ones. The correlation between the actuarial and subjective estimates is 0.790, or 62.4% common variance. The partial correlation between them adjusting for age is 0.078, which is significantly greater than zero ($p = 0.001$, 2-tailed test), but only 0.6% common variance. Thus most, but not all, of the correlation between subjective and actuarial estimates of life expectancy can be attributed to the correlation of both with age.

*Cohort improvement*

The results fail to confirm the idea that people take cohort mortality trends into account when estimating personal life expectancy. In this sample the mean difference of 1.172 years is significantly greater than zero ($p < 0.000$, $t = 4.486$). The difference scores do not correlate significantly with age $r = 0.006$, $p = 0.791$). Thus, subjective estimates overall show an optimistic bias of about one year that does not increase or decrease with age.

The regression results in Table 3 also contradict the hypothesis that the gap between subjective and actuarial life expectancy declines in older age groups. If anything it may get larger. Model 1a shows the basic regression. The coefficient of age in row 3 is positive rather than negative, and not significantly different from zero.

The failure to find a negative effect of age on the gap between subjective and current-table actuarial life expectancy could result from age differences in reluctance to answer the longevity question. However the hazard adjustment suggests that the gap actually may increase with age once age group differences in reporting are controlled. Row 3 in Table 1 shows that adjusting for the hazard of nonresponse increases the size of the positive coefficient associated with age and makes it statistically significant. The result deviates sharply from the hypothesis that age decreases the gap between subjective and actuarial life expectancy. If anything, people seem to get more optimistic with age.

The results do not support the cohort improvement hypothesis. Younger respondents apparently do not incorporate favorable mortality trends into their subjective expectations.

*Sex and race anomalies*

A number of results confirm the hypothesized sex and race anomalies. Fig. 3 illustrates the crude means and their 95% confidence limits, comparing subjective to actuarial estimates. The mean difference is −0.711 for white females, 3.890 for black females, 3.158 for white males, and 10.348 for black males, as given in Table 2. All four mean differences are statistically different from zero at the 0.05 level or more (2-tailed test). In a sense, the anomalies exist because the longevity estimates do not vary much across categories of sex and race. The $\eta$ correlation coefficient for group differences in subjective longevity is 0.061, which is not significantly different from zero ($F=2.367$, df = 3 and 1887, $p=0.069$). (When the independent variable is a set of nominal categories, $\eta$ and $\eta^2$ replace $r$ and $r^2$.) Thus sex and race explain only about 0.5% of the variance in subjective longevity ($0.069^2=0.005$). By comparison, the $\eta$ for group differences in actuarial longevity is 0.646, so that sex and race explain about 41.8% of the variance. Females of both races and black males expect to live about 82 years on average and white males expect to live about a year less than that, to 81. By comparison the current-table actuarial estimates imply that white females in this sample should expect to live to about age 83, that black females and white males should expect to live about five years less, to age 78, and that black males should expect to live about 6.5 years less than that, to age 71.5.

The multiple regressions in Table 3 also confirm the sex and race anomalies. In addition they show that the anomalies cannot be explained by reluctance to answer the longevity question, by males or blacks expecting larger declines in mortality rates, or by personal attributes that might encourage optimism or distinguish the composition of the sample from that of the population on which actuarial estimates are based. Rows 1 and 2 of Table 3 show a sex anomaly of about 3.5 years and a race anomaly of about 6 or 7 years across all models. The adjustment for the hazard of not reporting subjective longevity decreases the sex anomaly by about half a year and increases the race anomaly by about 1.5 years. The interaction models provide no consistent evidence that males or blacks implicitly expect larger cohort declines in mortality. Model 2a's coefficients seem to suggest the possibility that blacks might expect improvements in mortality that whites do not. In model 2a the age slope is 0.023 for whites and $0.023 - 0.091 = -0.068$ for blacks. However the slope for blacks is not significantly different from zero, and it becomes positive with adjustment for the hazard of nonresponse. In model 2b the age slope is 0.116 for white females, 0.081 for white males, 0.038 for black females, and 0.003 for black males. Adjusting for covariates in model 3 changes the overall picture very little. (Note that the hazard score is a nonlinear function of variables that also get treated as separate covariates in model 3.) The sex anomaly remains essentially the same. The race anomaly decreases by about 1.5 years, suggesting that blacks in the sample have reason to expect somewhat better survival than the black population as a whole. Nevertheless a race anomaly of about 6 years remains.

## Discussion

When compared across age groups, average subjective life expectancies track the current-table actuarial estimates well. In the aggregate Americans seem to understand roughly how much time they probably have left. They know reasonably well where they are in life. The subjective and actuarial estimates share over 60% of their variance in common. The two estimates correspond because age heavily influences both of them, as it must when longevity acts as a cap. Individuals cap longevity at various ages, and nudge it upward to stay ahead of current age. Nevertheless, getting older moves people closer to that subjective cap.

It is difficult to say what determines the aggregate longevity people expect. It is tempting to think that knowledge of demographic projections might actually determine the aggregate subjective expectation. The mean subjective estimate lies remarkably close to the actuarial projection for the sample as a whole and for each age group. However other findings suggest little awareness of the nuances of demographic projections. Demographers project that younger adults can expect longer lives than current mortality tables imply. Economists argue that wise individuals will plan on it. The data show no sign that younger Americans take the favorable mortality trends into account. If anything, younger American adults make estimates closer to the actuarial ones based on current mortality rates. The models that adjust for the hazard of not reporting subjective longevity and for personal attributes that may influence sample participation find a positive effect of age on the gap between subjective and actuarial life expectancy, particularly for whites. Perhaps the simplest explanation is that continuing survival encourages greater optimism at older ages because it seems increasingly remarkable.

Incorporating knowledge of mortality trends would be quite sophisticated. It is no surprise that the public lacks that level of sophistication. In contrast there is nothing subtle about the sex and race differences in actuarial life expectancy. Nevertheless, the men in the sample expect to live almost as long as the women of the same race do, and the blacks in the sample expect to live as long as the whites of the same sex do. As a consequence males expect to live about three and a half years longer than current actuarial tables say they should, and blacks expect to live about seven and a half years longer. The reasons for this optimism are not clear. Men generally feel healthier than women, have fewer chronic diseases and impairments, and use fewer medical services. Blacks who participate in surveys are less socioeconomically marginal than the black population as whole. Nevertheless, adjustment for a large number of variables representing status and health accounts for little of the anomalous expectation. The adjustments leave the male overestimate essentially unchanged, and reduce the black overestimate by only 20%. It appears that the major demographic groups in the United States share a common image of normal longevity. Where that image comes from is a mystery.

If men and blacks have optimistic life expectancies, is that bad or good? What are the consequences of anomalous life expectancy? The labor economists concerned about retirement planning and timing seem to think that an accurate expectation is the best expectation. Some psychologists might argue with that. Even where retirement is concerned, people who expect to live longer might save more and retire later, which could be a good thing. Furthermore, a degree of optimism might boost emotional well-being. Indeed, positive psychological consequences could be the cause of optimism. The question is whether optimistic beliefs motivate effective action, or substitute for it. Perhaps one clue to the answer is that white women enjoy the longest actuarial life expectancy of the four sex-by-race groups. They are the only one of the four to expect shorter lives on average than actuarial estimates suggest.

In the end, what can be said about the scientific and political issues that motivated this line of research? Can economists and policy makers expect the public to make informed decisions based on widely disseminated expert projections? These results give no reason to think so. The striking correspondence of age-specific mean subjective life expectancy to actuarial projections is a fluke. The results give no reason to believe that the correspondence reflects knowledge of demographic projections. People know their lives will not go on forever. They imagine a length of life that seems reasonable and implicitly see the time remaining. Subjective longevity and life expectancy may influence morale and action. Where those subjective expectations come from remains an open question.

## Acknowledgements

The National Institute on Aging funded the survey of *Aging, Status and the Sense of Control* with grant NIA 1 RO1 AG12393 to JM (P.I.) and Catherine E. Ross (Co-P.I.). The data were collected by the Survey Research Laboratory of the University of Illinois. This analysis was supported by the NIA grant and by the College of Social and Behavioral Sciences at Ohio State University. I thank Catherine E. Ross for many ideas and suggestions, Krishnan Namboodiri for advice on life expectancy functions, Laurie Krivo for clues to the literature and Marieke Van Willigen for her perceptive search into remote corners of the literature.

## References

Berk, R.A., Ray, S.C., 1982. Selection biases in sociological data. Social Science Research 11, 352–398.

Breen, R., 1996. Regression Models: Censored, Sample Selected, or Truncated Data. Sage, Beverly Hills.

Consumer's Union, 1995. How long will you live? Consumer Reports on Health 7 (5), 51.

Goyder, J., 1987. The Silent Minority: Nonrespondents on Sample Surveys. Polity Press, Cambridge.

Groves, R.M., 1990. Theories and methods of telephone surveys. Annual Review of Sociology 16, 221–240.

Hamermesh, D.S., Hamermesh, F.W., 1983. Does perception of life expectancy reflect health knowledge? American Journal of Public Health 73, 911–914.

Hamermesh, D.S., 1985. Expectations, life expectancy and economic behavior. The Quarterly Journal of Economics 100, 389–408.

Handel, P.J., 1969. The relationship between subjective life expectancy, death anxiety, and general anxiety. Journal of Clinical Psychology 25, 39–42.

Heckman, J.J., 1979. Sample selection bias as a specification error. Econometrica 47, 153–161.

Hurd, M.D., McGarry, K., 1995. Evaluation of the subjective probabilities of survival in the health and retirement study. The Journal of Human Resources 30, S268–S292.

Joubert, C.E., 1992. Happiness, time consciousness and subjective life expectancy. Perceptual and Motor Skills 74, 649–650.

Juster, F.T., Suzman, R., 1995. An overview of the health and retirement survey. The Journal of Human Resources 30, S7–S56.

Kochanek, K.A., Hudson, B.L., 1995. Advanced report of final mortality statistics, 1992. Monthly Vital Statistics Report 43, 1–13.

Lovell, M.C., 1986. Tests of the rational expectations hypothesis. American Economic Review 76, 110–124.

Lund, L., Wright, W.E., 1994 Mitofsky–Waksberg vs. screened random digit dial: report on a comparison of the sample characteristics of two RDD survey designs. Presented at the Center for Disease Control's 11th Annual BRFSS Conference, Atlanta.

McDowell, I., Newell, C., 1987. Measuring Health: A Guide to Rating Scales and Questionnaires. Oxford University Press.

Nagi, S.Z., 1976. An epidemiology of disability among adults in the United States. Milbank Memorial Fund Quarterly 54, 439–468.

Nam, C.B., 1994. Understanding Population Change. F.E.Peacock, Itasce, IL.

Nam, C.B., Harrington, T.M., 1986. Factors shaping the morbidity–mortality expectations of youth: a socialization model. In: Mahadevan, K., Reddy, P.J., Naidu, D.A. (Eds.), Fertility and Mortality: Theory, Methodology and Empirical Issues. Sage, Beverly Hills, pp. 302–313.

Nelson, L.D., Honnold, J.A., 1980. Socialization and demographic determinants of mortality expectations. Population and Environment 3, 10–22.

Polluck, R.L., Suyderhoud, J.P., 1992. An empirical window on rational expectations formation. The Review of Economics and Statistics 74, 320–324.

Robbins, R.A., 1988a. Subjective life expectancy as a correlate of family life expectancy. Psychological Reports 62, 442.

Robbins, R.A., 1988b. Objective and subjective factors in estimating life expectancy. Psychological Reports 63, 47–53.

Ross, C.E., Bird, C.E., 1994. Sex stratification and health lifestyle: consequences for men's and women's perceived health. Journal of Health and Social Behavior 35, 161–178.

United States Bureau of the Census, 1995. Statistical Abstract of the United States 1995. Government Printing Office.

Verbrugge, L., 1986. From sneezes to adieu: stages of health for American men and women. Social Science & Medicine 22, 1195–1212.

Waksberg, J., 1978. Sampling methods for random digit dialing. Journal of the American Statistical Association 73, 40–46.

Weeks, J.R., 1996. Population: An Introduction to Concepts and Issues, 6th ed. Wadsworth, New York.

Winship, C., Mare, R.D., 1992. Models for sample selection bias. Annual Review of Sociology 18, 327–350.

Winship, C., Radbill, L., 1994. Sampling weights and regression analysis. Sociological Methods and Research 22 (2), 230–257.