Published in final edited form as:

J Clin Epidemiol. 2012 July ; 65(7): 764–777. doi:10.1016/j.jclinepi.2012.01.003.

Hearing, mobility, and pain predict mortality: a longitudinal population-based study

David Feeny^{a,b,c,*}, Nathalie Huguet^d, Bentson H. McFarland^e, Mark S. Kaplan^d, Heather Orpana^f, and Elizabeth Eckstrom^g

^aKaiser Permanente Northwest Center for Health Research, Portland, OR, USA

^bHealth Utilities Incorporated, Dundas, Ontario, Canada

^cUniversity of Alberta, Edmonton, Alberta, Canada

^dSchool of Community Health, Portland State University, Portland, OR, USA

^eDepartment of Psychiatry, Oregon Health & Science University, Portland, OR, USA

^fSchool of Psychology, University of Ottawa, Ottawa, Ontario, Canada

^gDivision of General Internal Medicine & Geriatrics, Department of Medicine, Oregon Health & Science University, Portland, OR, USA

Abstract

Objective—Measures of health-related quality of life (HRQL), including the Health Utilities Index Mark 3 (HUI3) are predictive of mortality. HUI3 includes eight attributes, vision, hearing, speech, ambulation, dexterity, cognition, emotion, and pain and discomfort, with five or six levels per attribute that vary from no to severe disability. This study examined associations between individual HUI3 attributes and mortality.

Study Design and Setting—Baseline data and 12 years of follow-up data from a closed longitudinal cohort study, the 1994/95 Canadian National Population Health Survey, consisting of 12,375 women and men aged 18 and older. A priori hypotheses were that ambulation, cognition, emotion, and pain would predict mortality. Cox proportional hazards regression models were applied controlling for standard determinants of health and risk factors.

Results—Single-attribute utility scores for ambulation (hazard ratio [HR] = 0.10; 0.04–0.22), hearing (HR = 0.18; 0.06–0.57), and pain (HR = 0.53; 0.29–0.96) were statistically significantly associated with an increased risk of mortality; ambulation and hearing were predictive for the 60+ cohort.

Conclusion—Few studies have identified hearing or pain as risk factors for mortality. This study is innovative because it identifies specific components of HRQL that predict mortality. Further research is needed to understand better the mechanisms through which deficits in hearing and pain affect mortality risks.

© 2012 Elsevier Inc. All rights reserved.

*Corresponding author. David Feeny, Kaiser Permanente Northwest Center for Health Research, 1209 SW Sixth Avenue, #801, Portland, OR 97204-1030, USA. Tel.: +971-255-0187; fax: +503-335-2428. dafeeny@comcast.net (D. Feeny).

An earlier version of the study was presented at the 137th Annual Meeting of the American Public Health Association, Philadelphia, November 7–11, 2009 and in a seminar at the National University of Singapore, February 5, 2010.

Keywords

Health Utilities Index Mark 3; Mortality; Predictive validity; Mortality; Longitudinal; Health-related quality of life

1. Introduction

In population health studies, there is substantial evidence that baseline indicators of overall health-related quality of life (HRQL), such as self-rated health (excellent, very good, good, fair, or poor) predict subsequent health events including death [1–9]. For example, using data from the Manitoba Longitudinal Study on Aging, Mossey and Shapiro [1] found that after controlling for objective health status, age, sex, life satisfaction, and income, those who reported their health to be poor were nearly three times as likely to die as those who reported their health to be excellent. Gold et al. [10] using data from the National Health and Nutrition Survey I Epidemiologic Follow-up Study showed that the overall score on an HRQL measure, the Health Utilities Index Mark 1 based on four attributes (physical function, role function, social-emotional function, and health problem), predicted subsequent mortality after controlling for other determinants of health, including chronic conditions, smoking, income, age, gender, and education. Similarly, Wilkins [11] and Kaplan et al. [12] provided evidence of the relationship between baseline overall Health Utilities Index Mark 3 (HUI3) scores and subsequent mortality. HUI3 includes eight attributes of health status: vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain and discomfort.

Given that baseline overall HUI3 scores predict mortality, which of the individual HUI3 attributes might account for that prediction? Or is it a combination of deficits in multiple attributes that is important? The primary purpose of this study was to examine the association between individual HUI3 attributes and mortality risk prospectively and with a nationally representative population-based sample after adjusting for key covariates.

2. Methods

2.1. Health Utilities Index Mark 3

HUI3 is a generic preference-based measure of health status and HRQL. There are five or six levels per HUI3 attribute [13–15]. Levels within each attribute range from no disability (e.g., able to hear what is said in a group conversation with at least three other people, without a hearing aid) to severe disability (e.g., unable to hear at all). The health state of a subject at a point in time is summarized by the combination of the levels for each of the eight attributes (Table 1). There is substantial evidence on the construct validity of HUI3 in population health surveys [16–23].

HUI3 provides both single-attribute and overall utility scores. Single-attribute utility scores for HUI3 are on a scale in which the most severe level of disability for that attribute has a score of 0.00 and no disability/normal has a score of 1.00 [14]. For instance, the single-attribute utility scores for hearing are level 1 = 1.00, level 2 = 0.86, level 3 = 0.71, level 4 = 0.48, level 5 = 0.32, and level 6 = 0.00. Overall HUI3 scores are on the conventional scale in which dead = 0.00 and perfect health = 1.00.

The HUI3 scoring function is based on community preferences obtained from a random sample of the Canadian population elicited using a visual analog scale (VAS) and the standard gamble (SG). All health states were assessed on the VAS; a subset of health states was assessed on the SG. A power function was estimated to convert VAS into SG scores. The validity of the scoring function was confirmed by an examination of agreement between

SG scores for 73 HUI3 health states obtained from a different random sample and scores derived from the HUI3 scoring function with an intraclass correlation coefficient of 0.88 [14].

2.2. Data

Data from the longitudinal Statistics Canada National Population Health Survey (NPHS) for 1994/95 through 2006/07 were used for the analyses. The NPHS is a closed cohort survey. The target population of the longitudinal NPHS component includes household residents in the 10 Canadian provinces in 1994/95 excluding persons living on Indian Reserves and Crown Lands, residents of health institutions, Canadian Forces bases, and some remote areas in Ontario and Quebec. Using a stratified, multistage random sampling procedure, 17,276 household members were selected to be interviewed every 2 years starting in 1994/95 to gather detailed health status, health service utilization, and sociodemographic data for the longitudinal component of the survey; see Tambay and Catlin [24] for a more complete description of the NPHS. Mortality was ascertained by proxy responses. Deaths up to December 31, 2005 were confirmed against the Canadian Vital Statistics Database [25]. In 13 cases, data on the date of death was missing. If the month of death was known, the date was imputed as the 15th; when the day and month were missing the day of death was imputed as 15 and month of death was imputed as June.

2.3. Independent variables

Single-attribute utility scores for each of the eight attributes are the key independent variables. The association among the 28 pairs of single-attribute scores was assessed.

2.4. Controlling for potential confounders

Standard risk factors and determinants of health identified by previous studies [12,26,27], all measured at baseline, were included in the analyses. These included sociodemographic factors (age, sex, marital status, household income, and education); number of chronic conditions associated with an elevated risk of mortality (high blood pressure, chronic bronchitis or emphysema, diabetes, heart disease, cancer; and stroke); possibly associated with an elevated risk of mortality (asthma and Alzheimer Disease or other dementia); and not associated with an elevated risk of mortality (food allergies, allergies other than food allergies, arthritis or rheumatism, back problems excluding arthritis, migraine headaches, sinusitis, epilepsy, stomach or intestinal ulcers, urinary incontinence, cataracts, glaucoma, and other long-term conditions); body mass index; health behaviors (smoking, physical activity, and alcohol use); psychological health and resources (psychological distress, sense of coherence, and chronic stress); and perceived social support. The number of other attributes affected with any disability was included to assess the relative roles of specific deficits vs. combinations of deficits. Many chronic conditions often affect multiple attributes. For instance, type-2 diabetes might affect vision, ambulation, dexterity, cognition, emotion, and pain and discomfort.

Records with missing values for any of the covariates, except for income, were excluded from the analysis. Missing income was represented with an additional dummy variable. Some 1,742 records were excluded. Those excluded from the analyses were more likely to be younger, male, to have a lower level of education, and to be an immigrant.

2.4.1. A priori hypotheses—A priori predictions about the attributes expected to be associated with mortality were specified. Given the substantial evidence that deficits in physical health are predictive of mortality [28], lower scores on ambulation were expected to be associated with an increased risk of mortality. In addition, lower emotion, cognition [29], and pain scores were expected to be associated with an increased risk of mortality.

Deficits in emotional health, cognition, and burdens because of pain are often associated with serious health problems, such as stroke, cardiovascular disease, and diabetes [21,30,31]. Further, there is substantial variation among individuals in the burdens associated with these four attributes.

2.5. Statistical analysis

The Cox proportional hazards model was used to assess mortality associated with each of the eight attributes, controlling for an array of potential confounders. Single-attribute HUI3 utility scores for each attribute were entered as continuous variables. Data were censored on the date of the last completed interview. All analyses were conducted using SAS, Version 9.1 (SAS Institute Inc., Cary, NC, USA). The bootstrap resampling technique was used [32] to account for the complex sampling design and to estimate hazard ratios (HRs), confidence intervals, and levels of significance. Weights used in adjustment for the sampling design were computed by taking into account poststratification and nonresponse in 1994/95. In addition, Yeo et al. [32] explain that the bootstrap weights were calculated in such a way as to generate accurate variance estimates while precluding data users from being able to identify respondents.

Cox models were estimated for two cohorts: those 18 years of age or older at baseline and those 60 years of age or older at baseline. The latter reflects the fact that deaths are concentrated at older ages.

Simulations were performed to illustrate the mortality impact of individual attributes, the HRs associated with each level within that attribute. By definition in the Cox model, the HRs were independent of variables other than the attribute being examined. Treating the single-attribute utility scores for the relevant attributes as continuous variables, the HRs for each level for each of the attributes that was a statistically significant predictor of mortality were then calculated for the 18+ and the 60+ cohorts. The unit of change in the simulations is a movement of one level within that attribute. Typically a change in level corresponds to a change of 0.05 or more (often substantially more) in the single-attribute utility score.

The study was approved by the Institutional Review Board of Portland State University.

3. Results

The main analysis is based on a total of 12,375 respondents who were 18 years of age or older at baseline. There were 1,701 deaths observed among 121,166 person-years of follow-up. Nearly 13% of the 14,177 respondents aged 18 and older who were interviewed at baseline were excluded from the analysis because of missing data on one or more covariates. Table 2 describes the sociodemographic characteristics and independent variables at baseline. Six percent of decedents were ages 18–49 at the time of their death, 8% were 50–59, 15% were 60–69, and 72% were 70+. Characteristics of those 60 years of age or older at baseline also are displayed.

The distribution of HUI3 levels within each attribute at baseline for the 18+ and 60+ cohorts is listed in Table 3. Very few subjects reported levels 5 and 6 (severe disability [33,34]) for most attributes. For 18+, the prevalence of severe disability at baseline exceeded 1% only for cognition and pain; for 60+, the prevalence of severe disability varied from 1.2% to 6.1%. Two percent of subjects 18–39 years of age at baseline had any impairment in hearing (levels 2–6), 3% had any hearing impairment in the 40–54 age range, 8% in the 44–59 age range, and 21% in the 70+ group.

For 18+ at baseline, 22.6% of subjects reported no attributes affected whereas the prevalence of one, two, three, four, five, and six or more attributes affected was 37.7%, 24.3%, 10.7%, 3.5%, 1.0%, and 0.2%, respectively. In general, there was relatively little association among the single-attribute HUI3 scores. Among the 28 pair wise comparisons, classifying correlations of <0.10 as negligible, 0.10–0.29 as small, 0.30–0.49 as medium, and 0.50 as large [35], the observed correlations (all statistically significant) were negligible in 10 cases, small in 17 cases, and large in one case. The minimum correlation observed, 0.04, was between vision and emotion; the maximum observed, 0.32, was between ambulation and pain. The correlation between hearing and ambulation was 0.11. For the 60+ cohort at baseline, 5.6% of subjects reported no attributes affected whereas the prevalence of one, two, three, four, five, and six or more attributes affected was 31.3%, 29.2%, 17.6%, 8.1%, 3.5%, and 3.9%, respectively.

Results from the Cox proportional hazards model for the 18+ cohort were consistent with a priori expectations and results from previous studies. Being widowed, being male, less than the highest level of income, less than a high school education, being underweight, and smoking were associated with an elevated risk of mortality (Table A1). Further, as expected, the HRs rose sharply with age, especially for those over 60. The HR was importantly higher for those with a life-limiting chronic condition and for the physically inactive. The number of attributes affected also was statistically significant. The bottom rows of Table A1 and Table 4 show negative twice the log likelihood (a crude goodness of fit measure) for the several models. The values are quite similar to each other with the exception of that for ambulation.

For each attribute there was an inverse relationship between the single-attribute utility score and risk of mortality (Table A1). The results for hearing, ambulation, and pain were statistically significant (Table 4). Results are only partially consistent with our a priori expectations. As predicted, ambulation and pain were predictive of mortality; however, cognition and emotion were not. Impaired hearing has not previously been found to have a clear association with mortality.

Results were largely similar for the 60+ cohort (Table A2). Ambulation and hearing are predictive of mortality. The result for pain and discomfort is no longer statistically significant (Table 4).

Results of the simulations performed to illustrate the mortality impact of deficits in hearing, ambulation, and pain for 18+ and hearing and ambulation for 60+ are presented in Table 5. Disability in hearing showed a stepwise and strong impact on mortality. Disability in ambulation was associated with a stepwise increase in mortality from level 1 (no disability) to levels 5 and 6 (severe disability) that was substantial and statistically significant. Pain showed a milder, though still statistically significant, impact on mortality in the 18+ cohort but was not statistically significant in the 60+ cohort.

4. Discussion

In this large, population-based study with 12 years of follow-up, impaired ambulation, impaired hearing, and pain (only for 18+) were predictive of mortality. Contrary to our a priori predictions, cognition and emotion were not predictive of mortality and hearing was.

It is important to compare our results with previously reported findings. Disability in HUI3 ambulation was associated with increased risk of mortality in a stepwise and substantial fashion for both the 18+ and the 60+ cohorts. Given that HUI3 ambulation is an indicator of physical health, this result is not surprising. Many studies, controlling for an array of confounders, have linked physical health and mortality. Baseline scores from the Health

Assessment Questionnaire [36,37], a measure that includes physical functioning, have found it to be predictive of subsequent mortality in patients with rheumatoid arthritis [28,36,38–42], coronary disease [43], those who perceive themselves as being disabled [44], the elderly [45], in a cohort of nurses [8], and in the general population [46].

Lee et al. [47] found that baseline physical activity and cognition were predictive of mortality; see also ref. [48]. Hebert et al. [49] found that restrictions in mobility and cognitive impairment were predictive of mortality. In an analysis of data pooled from nine cohort studies, Studenski et al. [50] found that baseline gait speed was predictive of survival. Tsai et al. [51] found that both the physical health and the mental health summary scores of the Short Form-36 [52] were predictive of mortality; see also refs. [53–58].

That baseline hearing was predictive of subsequent mortality has not been widely reported. Barnett and Franks [59] using data from the National Health Interview Survey report that postlingual (after the acquisition of speech and language) onset of deafness elevated the risk of mortality but that after adjustment for other determinants of health, hearing loss was no longer statistically significant. Appollonio et al. [60,61] using data on a cohort of elderly Italians (70–75 at baseline) found that hearing impairment was predictive of mortality in males. Of course, hearing loss is associated with the aging process [62].

Other studies have reported on the relationship between vision and hearing impairment and mortality. Reuben et al. [63] reported that vision and hearing impairment is a risk factor for mortality and that hearing impairment is predictive of functional decline; see also refs. [64–70].

A number of studies report that hearing impairment is predictive of decline in health status and the onset of functional dependence [71,72] and the onset of anxiety [73]. Brennan et al. [74] using data from the Statistics Canada Participation and Activity Limitation Survey reported that impaired hearing is associated with age, inversely related to education, and associated with limitations in mobility, agility, and pain. Uhlmann et al. [75] report an association between hearing impairment and cognitive dysfunction. Lin et al. [76] using data from the Baltimore Longitudinal Study of Aging found that hearing loss was predictive of the incidence of dementia. Gates et al. [77] report that central auditory dysfunction predicts the onset of Alzheimer Disease. Hearing impairment is related to an elevated risk of falls [78–80]. Schneider et al. [81] report an association between impaired hearing and impaired mobility. Occupational and recreational exposure to noise and smoking is related to hearing loss [82]. Hearing loss also is related to family history [83] and a number of chronic conditions, including cardiovascular ones [84].

There is relatively little evidence on the relationships between pain and mortality. Andersson [85] using data from a Swedish cohort study reports an association between chronic pain and mortality but that when the full range of the determinants of health were controlled for, pain became statistically insignificant. It could be that pain is predictive of mortality in this study because it is a marker for the severity and/or duration of chronic conditions and health problems.

There are several limitations to the findings of our study. First, the power to detect an association between severe levels of disability within each attribute and mortality was limited by the small number of observations in levels, such as levels 5 and 6 (Table 3) and the limited number of deaths during the follow-up period. Limited power may account for the lack of statistically significant results for cognition and emotion, two of our *a priori* hypotheses. Similarly, lack of power did not allow us to perform gender-based analyses; rather gender was included as an independent variable in the analyses. A second limitation is that there may be measurement error associated with self-reporting on the ability to hear. A

number of studies, however, report satisfactory agreement between self-report and results based on audiometry [86–89]. Further, there is evidence for the validity of the HUI3 hearing attribute. HUI3 hearing was able to detect hearing loss associated with the use of cisplatin, an ototoxic platinum compound, in the treatment of neuroblastoma in children [90]. A third possible limitation is that the results reported here are based on data from a representative sample of the community-dwelling population aged 18+ at baseline. Predicting subsequent mortality may be “easier” in cohort studies of patients already diagnosed with a particular disease or in cohorts of older individuals [8]. However, it is notable that baseline overall HRQL and single-attribute scores for hearing, ambulation, and pain are predictive of mortality in a cohort without the “selection bias” associated with being diagnosed with a health problem or being older.

There are several possible explanations for the association between hearing impairment and mortality. First, hearing impairment may increase the risk of accident and injury [79,91–93]. Second, impaired hearing may be a marker for neurological decline [29,76,77,84,94] not captured by typical cognition scales that focus on memory and problem solving. It also is possible that declines in cognitive functioning, resulting in attenuated communication and language comprehension, are interpreted as hearing problems rather than being ascribed to cognition [67]. Poor comprehension may be an early marker of cognitive decline and aging [75,95]. Third, impaired hearing may adversely affect communication and social interaction and the resulting social isolation may lead to declines in physical and mental health [76,95–101]. Fourth, impaired hearing and deafness are associated with less educational achievement, lower rates of employment, a lower likelihood of a managerial or professional occupation, and lower income [92]. Using data from the 2000/01 Canadian Community Health Survey in which hearing was assessed by HUI3, Woodcock and Pole [92] note that those with any impairment in hearing were more likely than those without any hearing impairment to experience a high level of work stress and symptoms of depression; see also ref. [102]. Fifth, in some cases deafness may be the consequence of systemic disease (some brain tumors) or their treatment (platinum compounds used in the treatment of some cancers) [90]. Unsurprisingly, at baseline the prevalence of any hearing impairment was the highest in those 70 years of age or older (21%) and 72% of deaths were 70+ at the time of death. Further research is needed to identify the mechanism(s) through which hearing loss increases the risk of mortality.

The novel finding in our study that disability in hearing is associated with increased mortality may have important clinical and public health implications, especially given the prevalence of hearing loss [103]. Yueh et al. [98] discuss the recommendations for screening for hearing loss released by various agencies and organizations, including the 1996 United States Preventive Services Task Force (currently under review) and the 1994 Canadian Task Force on Preventive Health Care. They note both the underdetection and the undertreatment of hearing problems. Screening for impaired hearing is routine in older age groups but may also be indicated for younger people, especially if they have occupational or recreational noise exposure. More steps to reduce noise exposure in these settings might result in improved HRQL and increased longevity. And for those with impaired hearing, reducing barriers to access to assistive devices or cochlear implants may ensure the least harm from impaired hearing. Cheng and Niparko [104], Francis et al. [105], and Damen et al. [106] provide evidence of substantial gains in HRQL associated with cochlear implants. Mulrow et al. [107] reported gains in HRQL at the 4-month follow-up assessment for those randomized to receive a hearing aid right away whereas HRQL was stable in the group randomized to wait (see also refs. [89,98,101,108]). Stark and Hickson [109] report gains in hearing/communication-specific HRQL in those receiving hearing aids and that gains also were experienced by their significant other. Hawkins et al. [110] document HRQL burdens

associated with hearing impairment. Strategies to increase adherence to the use of hearing aids also are important [98].

Further investigations to determine which aspects of health are associated with the risk of mortality are warranted. In particular, further investigation about the relative roles of specific deficits vs. the constellation of deficits is needed. Confirmation that specific deficits (such as hearing) are consistently associated with increased mortality can guide the development of targeted interventions likely to enhance longevity.

Acknowledgments

Funding: This work was supported by grants to Mark S. Kaplan from the National Institute on Aging at the National Institutes of Health ("Longitudinal Analysis of Health-Related Quality of Life in an Aging Population," R21 AG027129-01), the Retirement Research Foundation, the Canadian Studies Grant Program of the Canadian Embassy in Washington DC, and to David Feeny from the National Institute of Diabetes and Kidney Diseases at the National Institutes of Health ("Predictors of Weight and Quality of Life: A 12-Year National Longitudinal Study," R21 1R21DK080277-01A1). None of these agencies have reviewed or approved the manuscript.

The authors acknowledge the contributions of Jean-Marie Berthelot, Saeeda Khan, Kathryn O'Grady, Stephane Tremblay, Keiko Asakawa, Victor Stevens, Samuel Sheps, Darrell J. Tomkins, Ronald Barr, Daniel Schollaert, and Daphne Plaut to the research reported here. The authors also acknowledge Desiree Pheister and Robin Daily for their assistance with manuscript preparation.

Appendix

Table A1

Relative hazard of death by HUI3 attribute for 18+ at baseline

Independent variables	Vision	Hearing	Speech	Ambulation	Dexterity	Emotion	Cognition	Pain and discomfort
Attribute	0.57 (0.14–2.30)	0.18 (0.06–0.57) ^a	0.21 (0.00–215.06)	0.10 (0.04–0.23) ^b	0.39 (0.09–1.68)	0.31 (0.08–1.14)	0.79 (0.34–1.86)	0.53 (0.29–0.96) ^c
Number of other attributes	1.14 (1.07–1.22) ^b	1.10 (1.03–1.17) ^a	1.12 (1.05–1.19) ^a	1.05 (0.98–1.13)	1.11 (1.04–1.18) ^a	1.11 (1.04–1.18) ^a	1.14 (1.06–2.03) ^b	1.14 (1.03–1.23) ^a
Gender	1.81 (1.56–2.09) ^b	1.81 (1.56–2.10) ^b	1.81 (1.56–2.10) ^b	1.84 (1.58–2.13) ^b	1.81 (1.56–2.09) ^b	1.81 (1.56–2.10) ^b	1.81 (1.56–2.09) ^b	1.81 (1.56–2.10) ^b
Age	1.89 (0.93–3.80)	1.89 (0.94–3.81)	1.89 (0.94–3.81)	1.85 (0.92–3.72)	1.89 (0.94–3.81)	1.90 (0.94–3.85)	1.87 (0.93–3.77)	1.88 (0.93–3.78)
Marital status	5.52 (2.80–10.86) ^b	5.45 (2.77–10.70) ^b	5.41 (2.76–10.63) ^b	5.43 (2.78–10.62) ^b	5.44 (2.78–10.66) ^b	5.47 (2.77–10.80) ^b	5.35 (2.73–10.48) ^b	5.37 (2.74–10.52) ^b
Education	14.02 (7.21–27.25) ^b	13.52 (6.97–26.23) ^b	13.43 (6.93–26.00) ^b	13.65 (7.07–26.32) ^b	13.52 (6.99–26.14) ^b	13.47 (6.92–26.24) ^b	13.15 (6.78–25.52) ^b	13.28 (6.86–25.70) ^b
Employment	30.45 (15.98–58.01) ^b	29.24 (15.40–55.52) ^b	29.13 (15.36–55.24) ^b	30.27 (16.00–57.24) ^b	29.43 (15.54–55.77) ^b	29.25 (15.33–55.82) ^b	28.57 (15.05–54.24) ^b	28.86 (15.24–54.66) ^b
Health status	56.31 (29.24–108.46) ^b	54.29 (28.33–104.04) ^b	54.25 (28.30–104.00) ^b	56.53 (29.50–108.31) ^b	54.85 (28.63–105.06) ^b	55.01 (28.55–105.96) ^b	53.09 (27.61–102.06) ^b	54.06 (28.20–103.61) ^b
Disability	132.55 (67.18–261.53) ^b	129.19 (65.98–252.93) ^b	130.31 (66.36–255.89) ^b	131.22 (66.93–257.28) ^b	132.53 (67.62–259.75) ^b	132.09 (67.09–260.07) ^b	128.46 (65.17–253.22) ^b	129.41 (65.74–254.72) ^b
Marital status	1.28 (0.99–1.63)	1.29 (1.01–1.65)	1.28 (1.01–1.63)	1.27 (0.99–1.62)	1.28 (1.00–1.63) ^c	1.27 (1.00–1.63)	1.27 (0.99–1.62)	1.28 (1.00–1.63)
Age	1.22 (1.01–1.47) ^c	1.23 (1.02–1.47) ^c	1.22 (1.01–1.46) ^c	1.20 (0.99–1.44)	1.22 (1.01–1.46) ^c	1.21 (1.01–1.46) ^c	1.22 (1.01–1.47) ^c	1.22 (1.02–1.47) ^c
Married/divorced	0.91 (0.71–1.15)	0.91 (0.72–1.16)	0.91 (0.71–1.15)	0.90 (0.71–1.15)	0.91 (0.71–1.15)	0.90 (0.71–1.15)	0.90 (0.71–1.14)	0.90 (0.71–1.14)
Gender	0.88 (0.57–1.38)	0.89 (0.57–1.39)	0.89 (0.57–1.38)	0.88 (0.57–1.37)	0.89 (0.57–1.38)	0.89 (0.57–1.38)	0.88 (0.57–1.38)	0.88 (0.57–1.37)
Marital status	1.54 (1.09–2.18) ^c	1.54 (1.09–2.18) ^c	1.55 (1.10–2.19) ^c	1.54 (1.09–2.16) ^c	1.55 (1.09–2.19) ^c	1.54 (1.09–2.18) ^c	1.55 (1.09–2.19) ^c	1.55 (1.10–2.19) ^c
Education	1.41 (1.02–1.94) ^c	1.41 (1.02–1.94) ^c	1.42 (1.03–1.95) ^c	1.41 (1.03–1.93) ^c	1.42 (1.03–1.95) ^c	1.42 (1.03–1.95) ^c	1.42 (1.03–1.95) ^c	1.41 (1.02–1.94) ^c
Health status	1.37 (1.00–1.88) ^c	1.37 (1.00–1.88) ^c	1.38 (1.01–1.89) ^c	1.40 (1.03–1.91) ^c	1.38 (1.01–1.89) ^c	1.38 (1.01–1.88) ^c	1.39 (1.01–1.90) ^c	1.38 (1.01–1.89) ^c
Marital status	1.20 (1.03–1.40) ^c	1.20 (1.02–1.40) ^c	1.20 (1.03–1.40) ^c	1.20 (1.02–1.40) ^c	1.20 (1.03–1.40) ^c	1.21 (1.03–1.41) ^c	1.19 (1.02–1.40) ^c	1.19 (1.02–1.39) ^c
Age	1.20 (0.96–1.50)	1.20 (0.96–1.50)	1.20 (0.96–1.50)	1.21 (0.97–1.51)	1.20 (0.96–1.50)	1.21 (0.97–1.51)	1.20 (0.96–1.50)	1.19 (0.95–1.50)
Health conditions	1.76 (1.53–2.02) ^b	1.78 (1.55–2.05) ^b	1.77 (1.54–2.03) ^b	1.75 (1.52–2.02) ^b	1.77 (1.54–2.03) ^b	1.77 (1.54–2.04) ^b	1.77 (1.54–2.03) ^b	1.76 (1.53–2.03) ^b
Associated with mortality	1.18 (0.90–1.54)	1.19 (0.91–1.55)	1.18 (0.90–1.54)	1.15 (0.87–1.53)	1.18 (0.90–1.55)	1.18 (0.90–1.55)	1.18 (0.90–1.54)	1.16 (0.88–1.52)
Associated with disability	1.03 (0.89–1.19)	1.04 (0.90–1.20)	1.04 (0.90–1.20)	1.03 (0.89–1.19)	1.05 (0.91–1.21)	1.05 (0.91–1.21)	1.05 (0.91–1.21)	1.04 (0.90–1.19)

\$watermark-text

\$watermark-text

\$watermark-text

Independent variables	Vision	Hearing	Speech	Ambulation	Dexterity	Emotion	Cognition	Pain and discomfort
Regularly smoker	2.27 (1.85–2.78) ^b	2.30 (1.87–2.82) ^b	2.28 (1.86–2.79) ^b	2.29 (1.87–2.81) ^b	2.28 (1.86–2.79) ^b	2.28 (1.86–2.79) ^b	2.27 (1.85–2.79) ^b	2.25 (1.83–2.76) ^b
Occasional smoker	1.82 (1.28–2.60) ^b	1.83 (1.28–2.62) ^b	1.82 (1.27–2.60) ^b	1.82 (1.27–2.62) ^a	1.82 (1.28–2.61) ^b	1.83 (1.28–2.62) ^b	1.81 (1.26–2.59) ^a	1.80 (1.26–2.58) ^a
Never smoker	1.47 (1.25–1.74) ^b	1.49 (1.26–1.76) ^b	1.47 (1.25–1.74) ^b	1.50 (1.27–1.77) ^b	1.48 (1.25–1.74) ^b	1.47 (1.25–1.74) ^b	1.48 (1.25–1.75) ^b	1.47 (1.24–1.74) ^b
Alcohol activity								
Frequency: 4 to 11 times per month	1.05 (0.88–1.26)	1.05 (0.87–1.26)	1.06 (0.88–1.27)	1.05 (0.88–1.26)	1.06 (0.88–1.27)	1.06 (0.88–1.27)	1.06 (0.88–1.27)	1.06 (0.88–1.27)
Frequency: zero to three per month	1.27 (1.09–1.47) ^a	1.28 (1.10–1.49) ^a	1.28 (1.10–1.49) ^a	1.25 (1.08–1.46) ^a	1.28 (1.10–1.49) ^a	1.29 (1.11–1.49) ^b	1.27 (1.09–1.48) ^a	1.28 (1.10–1.48) ^a
Underweight (<18.5)	1.71 (1.22–2.41) ^a	1.71 (1.21–2.40) ^a	1.71 (1.21–2.40) ^a	1.59 (1.09–2.32) ^c	1.71 (1.22–2.41) ^a	1.69 (1.20–2.38) ^a	1.69 (1.20–2.38) ^a	1.70 (1.20–2.40) ^a
Overweight (25 to <30)	0.82 (0.70–0.95) ^a	0.82 (0.70–0.95) ^a	0.81 (0.70–0.94) ^a	0.83 (0.71–0.96) ^c	0.81 (0.70–0.95) ^a	0.81 (0.70–0.94) ^a	0.82 (0.70–0.95) ^a	0.82 (0.70–0.95) ^a
Obese (30 to <35)	0.85 (0.68–1.06)	0.85 (0.68–1.06)	0.85 (0.68–1.06)	0.85 (0.68–1.06)	0.85 (0.68–1.06)	0.85 (0.68–1.06)	0.85 (0.68–1.06)	0.85 (0.68–1.06)
Very obese (≥ 35)	1.29 (0.93–1.79)	1.29 (0.93–1.79)	1.29 (0.93–1.80)	1.28 (0.92–1.78)	1.29 (0.93–1.80)	1.30 (0.94–1.79)	1.30 (0.93–1.81)	1.29 (0.93–1.79)
Alcohol use								
Never drinks	1.16 (0.89–1.51)	1.17 (0.90–1.53)	1.16 (0.89–1.51)	1.17 (0.89–1.52)	1.16 (0.89–1.51)	1.15 (0.88–1.50)	1.15 (0.89–1.50)	1.15 (0.88–1.50)
Former drinker	1.13 (0.91–1.40)	1.14 (0.92–1.42)	1.14 (0.91–1.41)	1.11 (0.89–1.38)	1.14 (0.91–1.42)	1.13 (0.91–1.41)	1.13 (0.91–1.41)	1.12 (0.90–1.40)
Drink a day	0.95 (0.79–1.15)	0.95 (0.79–1.15)	0.95 (0.79–1.15)	0.95 (0.79–1.15)	0.95 (0.78–1.15)	0.95 (0.78–1.15)	0.95 (0.78–1.15)	0.95 (0.78–1.15)
Drinks daily	1.22 (0.85–1.74)	1.25 (0.88–1.78)	1.23 (0.86–1.75)	1.17 (0.80–1.70)	1.24 (0.87–1.76)	1.23 (0.87–1.75)	1.23 (0.86–1.75)	1.22 (0.86–1.75)
Alcohol chronic stress index	0.94 (0.89–0.99) ^c	0.94 (0.89–0.99) ^c	0.94 (0.89–0.99) ^c	0.94 (0.89–0.99) ^c	0.94 (0.89–0.99) ^c	0.94 (0.89–0.99) ^c	0.94 (0.89–0.99) ^c	0.94 (0.89–0.99) ^c
Level of coherence scale	1.00 (0.99–1.01)	1.00 (0.99–1.01)	1.00 (0.99–1.01)	1.00 (0.99–1.01)	1.00 (0.99–1.01)	1.00 (0.99–1.01)	1.00 (0.99–1.01)	1.00 (0.99–1.01)
Received social support	1.01 (0.93–1.09)	1.01 (0.93–1.09)	1.01 (0.93–1.09)	1.01 (0.94–1.09)	1.01 (0.93–1.09)	1.01 (0.93–1.09)	1.01 (0.93–1.09)	1.01 (0.93–1.09)
Biological distress scale	1.03 (0.99–1.05)	1.03 (1.00–1.05) ^c	1.03 (1.00–1.05) ^c	1.03 (1.00–1.05) ^c	1.03 (1.00–1.05) ^c	1.03 (0.99–1.05)	1.02 (1.00–1.05) ^c	1.03 (0.99–1.05)
(df = 38); <i>P</i> < 0.05	18,722	18,721	18,727	18,704	18,728	18,727	18,726	18,723

Abbreviations: –2LL, twice negative log likelihood; df, degree of freedom; BMI, body mass index; HUI3, Health Utilities Index Mark 3.

Categories are 18–29; married; upper income; more than high school degree; no chronic health conditions; never smoker; regular exercise; and one to two drinks a day. Chronic health conditions associated with mortality: high blood pressure; chronic bronchitis or emphysema; diabetes; heart disease; cancer; and suffered from the effects of a stroke. Chronic health conditions possibly associated with mortality: asthma and Alzheimer Disease or other dementia. Chronic health conditions not associated with mortality: food allergies; allergies other than food allergies; arthritis or rheumatism; back pain; excluding arthritis; migraine headaches; sinusitis; epilepsy; stomach or intestinal ulcers; urinary incontinence; cataracts; glaucoma; and other long-term conditions.

1.

01.

5.

Table A2

Relative hazard of death by HUI3 attribute for 60+ at baseline

Independent variables	Vision	Hearing	Speech	Ambulation	Dexterity	Emotion	Cognition	Pain and discomfort
HUI3 attribute	0.45 (0.10–2.50)	0.14 (0.04–0.48) ^a	0.03 (0.00–34.5)	0.11 (0.04–0.30) ^b	0.37 (0.09–1.54)	0.33 (0.05–2.03)	0.80 (0.32–2.01)	0.60 (0.31–1.15)
Number of other attributes affected	1.12 (1.04–1.21) ^a	1.08 (1.00–1.16) ^b	1.10 (1.02–1.18) ^b	1.03 (0.95–1.13)	1.09 (1.01–1.18) ^b	1.12 (1.03–1.21) ^a	1.12 (1.02–1.22) ^b	1.10 (1.01–1.20) ^b
Male	1.91 (1.86–2.28) ^c	1.90 (1.06–2.27) ^c	1.89 (1.59–2.27) ^c	1.94 (1.62–2.32) ^c	1.90 (1.59–2.27) ^c	1.90 (1.59–2.27) ^c	1.90 (1.59–2.27) ^c	1.90 (1.59–2.27) ^c
Age								
70–79	1.88 (1.55–2.28) ^c	1.89 (1.55–2.29) ^c	1.90 (1.57–2.30) ^c	1.90 (1.57–2.31) ^c	1.90 (1.57–2.30) ^c	1.90 (1.58–2.31) ^c	1.84 (1.56–2.30) ^c	1.90 (1.57–2.30) ^c
80+	4.54 (3.49–5.90) ^c	4.58 (3.55–5.90) ^c	4.68 (3.63–6.04) ^c	4.57 (3.53–5.91) ^c	4.72 (3.66–6.09) ^c	4.68 (3.65–6.00) ^c	4.70 (3.65–6.06) ^c	4.68 (3.62–6.06) ^c
Marital status								
Single	1.38 (1.02–1.63) ^b	1.43 (1.06–1.91) ^b	1.38 (1.02–1.68) ^b	1.38 (1.02–1.85) ^b	1.39 (1.04–1.87) ^b	1.39 (1.02–1.87) ^b	1.38 (1.03–1.85) ^b	1.38 (1.03–1.87) ^b
Widowed	1.21 (0.99–1.48)	1.22 (1.00–1.50)	1.21 (0.98–1.48)	1.19 (0.98–1.46)	1.20 (0.93–1.48)	1.21 (0.99–1.48)	1.21 (0.98–1.48)	1.21 (0.99–1.50)
Separated/divorces	0.85 (0.62–1.17)	0.86 (0.62–1.17)	0.85 (0.62–1.17)	0.85 (0.62–1.17)	0.85 (0.61–1.16)	0.85 (0.62–1.17)	0.84 (0.61–1.15)	0.85 (0.62–1.16)
Income								
Missing	0.94 (0.54–1.64)	0.49 (0.54–1.65)	0.49 (0.54–1.64)	0.92 (0.53–1.59)	0.94 (0.54–1.64)	0.94 (0.54–1.64)	0.93 (0.53–1.64)	0.93 (0.53–1.63)
Low	1.38 (0.85–2.21)	1.36 (0.85–2.19)	1.38 (0.86–2.22)	1.35 (0.85–2.15)	1.37 (0.85–2.20)	1.37 (0.85–2.19)	1.38 (0.85–2.22)	1.38 (0.86–2.21)
Low middle	1.30 (0.83–2.04)	1.29 (0.83–2.02)	1.30 (0.83–2.04)	1.28 (0.83–1.98)	1.31 (0.84–2.04)	1.30 (0.83–2.03)	1.30 (0.83–2.05)	1.30 (0.83–2.03)
Upper middle	1.32 (0.85–2.07)	1.32 (0.85–2.06)	1.32 (0.85–2.06)	1.35 (0.87–2.08)	1.33 (0.85–2.07)	1.32 (0.85–2.05)	1.33 (0.85–2.08)	1.33 (0.85–2.06)
Education								
<High school	1.28 (1.07–1.53) ^a	1.27 (1.06–1.52) ^a	1.28 (1.07–1.53) ^a	1.28 (1.07–1.54) ^a	1.28 (1.07–1.53) ^a	1.29 (1.08–1.54) ^a	1.27 (1.06–1.52) ^a	1.27 (1.06–1.52) ^a
High school	1.26 (0.96–1.56)	1.26 (0.96–1.64)	1.26 (0.96–1.65)	1.29 (0.99–1.67)	1.26 (0.96–1.65)	1.27 (0.97–1.66)	1.26 (0.96–1.65)	1.25 (0.96–1.64)
Chronic health conditions								
Associated with mortality	1.56 (1.34–1.80) ^c	1.58 (1.37–1.82) ^c	1.56 (1.35–1.81) ^c	1.54 (1.33–1.79) ^c	1.56 (1.35–1.81) ^c	1.57 (1.35–1.81) ^c	1.57 (1.36–1.81) ^c	1.56 (1.35–1.80) ^c
Possibly associated with mortality	1.12 (0.82–1.51)	1.12 (0.83–1.52)	1.11 (0.81–1.51)	1.09 (0.79–1.50)	1.12 (0.82–1.52)	1.11 (0.82–1.51)	1.11 (0.82–1.51)	1.09 (0.80–1.48)
Not associated with mortality	1.09 (0.93–1.27)	1.10 (0.94–1.28)	1.10 (0.95–1.29)	1.09 (0.94–1.27)	1.10 (0.95–1.29)	1.10 (0.94–1.27)	1.11 (0.95–1.30)	1.10 (0.94–1.27)
Smoking								
Daily smoker	1.97 (1.55–2.50) ^c	2.20 (1.59–2.56) ^c	1.99 (1.57–2.53) ^c	1.99 (1.58–2.53) ^c	2.00 (1.57–2.53) ^c	2.00 (1.58–2.54) ^c	1.98 (1.56–2.52) ^c	1.97 (1.55–2.50) ^c
Occasional smoker	1.81 (1.19–2.76) ^a	1.81 (1.19–2.77) ^a	1.79 (1.17–2.73) ^a	1.83 (1.20–2.79) ^a	1.80 (1.18–2.75) ^a	1.80 (1.18–2.76) ^a	1.78 (1.17–2.72) ^a	1.78 (1.17–2.72) ^a
Former smoker	1.28 (1.28–1.81) ^c	1.55 (1.30–1.85) ^c	1.53 (1.28–1.82) ^c	1.55 (1.30–1.85) ^c	1.53 (1.28–1.82) ^c	1.52 (1.28–1.81) ^a	1.53 (1.28–1.82) ^c	1.52 (1.28–1.81) ^c
Physical activity								

\$watermark-text

\$watermark-text

\$watermark-text

Independent variables	Vision	Hearing	Speech	Ambulation	Dexterity	Emotion	Cognition	Pain and discomfort
Occasional: 4 to 11 times per month	1.04 (0.84–1.27)	1.03 (0.84–1.26)	1.05 (0.85–1.28)	1.04 (0.84–1.27)	1.04 (0.85–1.28)	1.04 (0.85–1.28)	1.04 (0.85–1.28)	1.04 (0.85–1.28)
Infrequent: – to 3 times per month	1.32 (1.11–1.58) ^a	1.34 (1.12–1.60) ^a	1.34 (1.12–1.60) ^a	1.31 (1.10–1.57) ^a	1.34 (1.12–1.60) ^a	1.33 (1.12–1.59) ^a	1.33 (1.11–1.59) ^a	1.33 (1.12–1.60) ^a
BMI								
Underweight (<18.5)	2.08 (1.41–3.07) ^c	2.12 (1.44–3.11) ^c	2.10 (1.43–3.09) ^c	1.94 (1.27–2.95) ^a	2.09 (1.42–3.08) ^c	2.09 (1.42–3.08) ^c	2.08 (1.41–3.00) ^c	2.07 (1.40–3.06) ^c
Overweight (25 to <30)	0.79 (0.66–0.96) ^b	0.80 (0.66–0.96) ^b	0.79 (0.65–0.95) ^b	0.80 (0.67–0.97) ^b	0.79 (0.66–0.95) ^b	0.80 (0.66–0.95) ^b	0.79 (0.66–0.95) ^b	0.79 (0.66–0.95) ^b
Obese (30 to <35)	0.89 (0.69–1.14)	0.90 (0.71–1.16)	0.89 (0.69–1.14)	0.89 (0.70–1.14)	0.89 (0.69–1.14)	0.89 (0.70–1.14)	0.89 (0.70–1.14)	0.89 (0.70–1.15)
Very obese (≥ 35)	1.29 (0.83–2.00)	1.30 (0.84–2.01)	1.30 (0.84–2.01)	1.28 (0.84–1.97)	1.30 (0.84–2.01)	1.31 (0.85–2.02)	1.30 (0.84–2.02)	1.29 (0.83–1.98)
Alcohol use								
Never drinks	1.16 (0.87–1.55)	1.18 (0.88–1.59)	1.16 (0.86–1.56)	1.17 (0.87–1.57)	1.16 (0.87–1.56)	1.16 (0.86–1.55)	1.16 (0.86–1.55)	1.16 (0.86–1.56)
Former drinker	1.19 (0.91–1.55)	1.22 (0.93–1.59)	1.20 (0.92–1.56)	1.17 (0.89–1.53)	1.20 (0.92–1.57)	1.20 (0.92–1.56)	1.20 (0.92–1.57)	1.19 (0.91–1.56)
<1 drink a day	0.96 (0.75–1.22)	0.96 (0.76–1.22)	0.96 (0.75–1.22)	0.95 (0.75–1.20)	0.96 (0.75–1.22)	0.95 (0.75–1.22)	0.96 (0.75–1.22)	0.96 (0.75–1.22)
3 drinks daily	1.28 (0.81–2.03)	1.85 (0.86–2.11)	1.31 (0.83–2.06)	1.19 (0.74–1.92)	1.31 (0.84–2.06)	1.31 (0.83–2.06)	1.30 (0.82–2.04)	1.31 (0.83–2.06)
General chronic stress index	0.95 (0.89–1.00)	0.95 (0.89–1.01)	0.95 (0.89–1.00)	0.95 (0.90–1.01)	0.94 (0.89–1.00)	0.95 (0.89–1.00)	0.94 (0.89–1.00)	0.95 (0.89–1.01)
Sense of coherence scale	1.00 (0.99–1.14)	1.00 (0.99–1.01)	1.00 (1.00–1.14)	1.00 (0.99–1.01)	1.00 (0.99–1.01)	1.00 (0.99–1.01)	1.00 (0.99–1.01)	1.00 (0.99–1.01)
Perceived social support index	1.03 (0.94–1.09)	1.03 (0.94–1.13)	1.04 (0.93–1.09)	1.04 (0.94–1.14)	1.01 (0.93–1.09)	1.03 (0.94–1.14)	1.01 (0.94–1.13)	1.03 (0.94–1.14)
Psychological distress scale	1.03 (0.99–1.06)	1.03 (0.99–1.07)	1.03 (0.99–1.06)	1.03 (0.99–1.06)	1.03 (0.99–1.05)	1.03 (0.99–1.06)	1.03 (0.99–1.06)	1.03 (0.99–1.07)
–2LL (df = 38); $P < 0.05$	12.496	12.491	12.499	12.483	12.501	12.498	12.500	12.498

Referent categories are 18–29; married; upper income; more than high school degree; no chronic health conditions; never smoker; regular exercise; and one to two drinks a day. Chronic health conditions associated with mortality: high blood pressure; chronic bronchitis or emphysema; diabetes; heart disease; cancer; and suffered from the effects of a stroke. Chronic health conditions possibly associated with mortality: asthma and Alzheimer Disease or other dementia. Chronic health conditions not associated with mortality: food allergies; allergies other than food allergies; arthritis or rheumatism; back problems excluding arthritis; migraine headaches; sinusitis; epilepsy; stomach or intestinal ulcers; urinary incontinence; cataracts; glaucoma; and other long-term conditions.

^a $p < 0.01$.

^b $p < 0.05$.

^c $p < 0.001$.

References

1. Mossey JM, Shapiro E. Self-rated health: a predictor of mortality among the elderly. *Am J Public Health*. 1982; 72:800–808. [PubMed: 7091475]
2. DeSalvo KB, Fan VS, McDonell MB, Fihn SD. Predicting mortality and healthcare utilization with a single question. *Health Serv Res*. 2005; 40:1234–1246. [PubMed: 16033502]
3. Benjamins MR, Hummer RA, Eberstein IW, Nam CB. Self-reported health and adult mortality risk: an analysis of cause-specific mortality. *Soc Sci Med*. 2004; 59:1297–1306. [PubMed: 15210100]
4. Burstrom B, Fredlund P. Self rated health: is it as good a predictor of subsequent mortality among adults in lower as well as in higher social classes? *J Epidemiol Community Health*. 2001; 55:836–840. [PubMed: 11604441]
5. Kaplan GA, Camacho T. Perceived health and mortality: a nine-year follow-up of the human population laboratory cohort. *Am J Epidemiol*. 1983; 117:292–304. [PubMed: 6829557]
6. Bowling, A. *Measuring Health: a review of Quality of Life Measurement Scales*. 2nd ed.. Maidenhead Berkshire, UK: Open University Press; 1999.
7. Idler EL, Benyamini Y. Self-rated health and mortality: a review of twenty-seven community studies. *J Health Soc Behav*. 1997; 38:21–37. [PubMed: 9097506]
8. Kroenke CH, Kubzansky LD, Adler N, Kawachi I. Prospective change in health-related quality of life and subsequent mortality among middle-aged and older women. *Am J Public Health*. 2008; 98:2085–2091. [PubMed: 18511734]
9. DeSalvo KB, Bloser N, Reynolds K, He J, Muntner P. Mortality prediction with a single general self-rated health question. A meta-analysis. *J Gen Intern Med*. 2006; 21:267–275. [PubMed: 16336622]
10. Gold MP, Franks P, Erickson P. Assessing the health of the nation. The predictive validity of a preference-based measure and self-rated health. *Med Care*. 1996; 34:163–177. [PubMed: 8632690]
11. Wilkins K. Predictors of death in seniors. *Health Rep*. 2006; 16:57–67. [PubMed: 16646275]
12. Kaplan MS, Berthelot JM, Feeny DH, McFarland B, Kahn S. The predictive validity of two measures of health-related quality of life: mortality in a longitudinal population-based study. *Qual Life Res*. 2007; 16:1539–1546. [PubMed: 17899447]
13. Furlong WJ, Feeny DH, Torrance GW, Barr RD. The Health Utilities Index (HUI) system for assessing health-related quality of life in clinical studies. *Ann Med*. 2001; 33:375–384. [PubMed: 11491197]
14. Feeny DH, Furlong W, Torrance GW, Goldsmith CH, Zhu Z, DePauw S, et al. Multi-attribute and single-attribute utility functions for the health utilities index mark 3 system. *Med Care*. 2002; 40:113–128. [PubMed: 11802084]
15. Horsman J, Furlong W, Feeny D, Torrance G. The Health Utilities Index (HUI®): concepts, measurement properties and applications. *Health Qual Life Outcomes*. 2003; 16(1):54. [PubMed: 14613568]
16. Feeny D, Huguette N, McFarland BH, Kaplan MS. The construct validity of the Health Utilities Index Mark 3 in assessing mental health in population health surveys. *Qual Life Res*. 2009; 18:519–526. [PubMed: 19277898]
17. Maddigan SL, Feeny DH, Majumdar SR, Farris KB, Johnson JA. Understanding the determinants of health for people with type 2 diabetes. *Am J Public Health*. 2006; 96:1649–1655. [PubMed: 16873750]
18. Maddigan SL, Feeny DH, Majumdar SR, Farris KB, Johnson JA. Health Utilities Index mark 3 demonstrated construct validity in a population-based sample with type 2 diabetes. *J Clin Epidemiol*. 2006; 59:472–477. [PubMed: 16632135]
19. Asakawa K, Feeny D, Senthilselvan A, Johnson JA, Rolfson D. Do the determinants of health differ between people living in the community and in institutions? *Soc Sci Med*. 2009; 69:345–353. [PubMed: 19527920]
20. Asakawa K, Rolfson D, Senthilselvan A, Feeny D, Johnson JA. Health Utilities Index Mark 3 showed valid in Alzheimer Disease, arthritis, and cataracts. *J Clin Epidemiol*. 2008; 61:733–739. [PubMed: 18359192]

21. Grootendorst P, Feeny D, Furlong W. Health Utilities Index Mark 3: evidence of construct validity for stroke and arthritis in a population health survey. *Med Care*. 2000; 38:290–299. [PubMed: 10718354]
22. Pohar SL, Jones CA, Warren S, Turpin KV, Warren K. Health status and health care utilization of multiple sclerosis in Canada. *Can J Neurol Sci*. 2007; 34:167–174. [PubMed: 17598593]
23. Pohar SL, Jones CA. The burden of Parkinson disease (PD) and concomitant comorbidities. *Arch Gerontol Geriatr*. 2009; 49:317–321. [PubMed: 19135266]
24. Tambay JL, Catlin G. Sample design of the national population health survey. *Health Rep*. 1995; 7:29–42. [PubMed: 7578995]
25. National population health survey household component cycle 1 to cycle 7 longitudinal documentation. Ottawa, Canada: Statistics Canada; 2008. Statistics Canada.
26. Evans RG, Stoddart GL. Producing health, consuming health care. *Soc Sci Med*. 1990; 31:1347–1363. [PubMed: 2126895]
27. Hertzman, C.; Frank, JW.; Evans, RG. Heterogeneities in health status and the determinants of population health. In: Evans, RG.; Barer, ML.; Marmor, TR., editors. *Why are some people healthy and others not? The determinants of health of populations*. New York, NY: Aldine De Gruyter; 1994. p. 67–92.
28. Leigh JP, Fries JF. Mortality predictors among 263 patients with rheumatoid arthritis. *J Rheumatol*. 1991; 18:1307–1312. [PubMed: 1757929]
29. Smits CH, Deeg DJ, Kriegsman DM, Schmand B. Cognitive functioning and health as determinants of mortality in an older population. *Am J Epidemiol*. 1999; 150:978–986. [PubMed: 10547144]
30. Garster NC, Palta M, Sweitzer NK, Kaplan RM, Fryback DG. Measuring health-related quality of life in population-based studies of coronary heart disease: comparing six generic indexes and a disease-specific proxy score. *Qual Life Res*. 2009; 18:1239–1247. [PubMed: 19760103]
31. Wexler DJ, Grant RW, Wittenberg E, Bosch JL, Cagliero E, Delahanty L, et al. Correlates of health-related quality of life in type 2 diabetes. *Diabetologia*. 2006; 49:1489–1497. [PubMed: 16752167]
32. Yeo, D.; Mantel, H.; Liu, TP. *Proceedings of the Survey Research Methods Section*. Baltimore, MD: American Statistical Association; 1999. Bootstrap variance estimation for the National Population Health Survey.
33. Feeny DH, Furlong W, Saigal S, Sun J. Comparing directly measured standard gamble scores to HUI2 and HUI3 utility scores: group- and individual-level comparisons. *Soc Sci Med*. 2004; 58:799–809. [PubMed: 14672594]
34. Feng Y, Bernier J, McIntosh C, Orpana H. Validation of disability categories derived from Health Utilities Index Mark 3 scores. *Health Rep*. 2009; 20:1–8.
35. Cohen, J. *Statistical power analysis for the behavioral sciences*. 2nd ed.. Hillsdale, NJ: Lawrence Erlbaum Associates; 1988.
36. Bruce B, Fries JF. The Stanford Health Assessment Questionnaire: a review of its history, issues, progress, and documentation. *J Rheumatol*. 2003; 30:167–178. [PubMed: 12508408]
37. Bruce B, Fries JF. The Health Assessment Questionnaire (HAQ). *Clin Exp Rheumatol*. 2005; 23:S14–S18. [PubMed: 16273780]
38. Farragher TM, Lunt M, Bunn DK, Silman AJ, Symmons DP. Early functional disability predicts both all-cause and cardiovascular mortality in people with inflammatory polyarthritis: results from the Norfolk Arthritis Register. *Ann Rheum Dis*. 2007; 66:486–492. [PubMed: 17090565]
39. Yelin E, Trupin L, Wong B, Rush S. The impact of functional status and change in functional status on mortality over 18 years among persons with rheumatoid arthritis. *J Rheumatol*. 2002; 29:1851–1857. [PubMed: 12233878]
40. Wolfe F, Michaud K, Gefeller O, Choi HK. Predicting mortality in patients with rheumatoid arthritis. *Arthritis Rheum*. 2003; 48:1530–1542. [PubMed: 12794820]
41. Naz SM, Farragher TM, Bunn DK, Symmons DP, Bruce IN. The influence of age at symptom onset and length of followup on mortality in patients with recent-onset inflammatory polyarthritis. *Arthritis Rheum*. 2008; 58:985–989. [PubMed: 18383358]

42. Wolfe F, Mitchell DM, Sibley JT, Fries JF, Bloch DA, Williams CA, et al. The mortality of rheumatoid arthritis. *Arthritis Rheum.* 1994; 37:481–494. [PubMed: 8147925]
43. van Domburg RT, Schmidt PS, van den Brand MJ, Erdman RA. Feelings of being disabled as a predictor of mortality in men 10 years after percutaneous coronary transluminal angioplasty. *J Psychosom Res.* 2001; 51:469–477. [PubMed: 11602216]
44. van der Vlugt MJ, van Domburg RT, Pedersen SS, Veerhoek RJ, Leenders IM, Pop GA, et al. Feelings of being disabled as a risk factor for mortality up to 8 years after acute myocardial infarction. *J Psychosom Res.* 2005; 59:247–253. [PubMed: 16223628]
45. Brody KK, Perrin NA, Dellapenna R. Advanced illness index: predictive modeling to stratify elders using self-report data. *J Palliat Med.* 2006; 9:1310–1319. [PubMed: 17187539]
46. Sokka T, Hakkinen A, Krishnan E, Hannonen P. Similar prediction of mortality by the health assessment questionnaire in patients with rheumatoid arthritis and the general population. *Ann Rheum Dis.* 2004; 63:494–497. [PubMed: 15082478]
47. Lee SJ, Lindquist K, Segal MR, Covinsky KE. Development and validation of a prognostic index for 4-year mortality in older adults. *JAMA.* 2006; 295:801–808. [PubMed: 16478903]
48. Lee Y. The predictive value of self assessed general, physical, and mental health on functional decline and mortality in older adults. *J Epidemiol Community Health.* 2000; 54:123–129. [PubMed: 10715745]
49. Hebert R, Bravo G, Korner-Bitensky N, Voyer L. Predictive validity of a postal questionnaire for screening community-dwelling elderly individuals at risk of functional decline. *Age Ageing.* 1996; 25:159–167. [PubMed: 8670547]
50. Studenski S, Perera S, Patel K, Rosano C, Faulkner K, Inzitari M, et al. Gait speed and survival in older adults. *JAMA.* 2011; 305:50–58. [PubMed: 21205966]
51. Tsai SY, Chi LY, Lee CH, Chou P. Health-related quality of life as a predictor of mortality among community-dwelling older persons. *Eur J Epidemiol.* 2007; 22:19–26. [PubMed: 17216549]
52. Ware JE Jr, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). 1. Conceptual framework and item selection. *Med Care.* 1992; 30:473–483. [PubMed: 1593914]
53. Myint PK, Luben RN, Surtees PG, Wainwright NW, Welch AA, Bingham SA, et al. Relation between self-reported physical functional health and chronic disease mortality in men and women in the European Prospective Investigation into Cancer (EPIC-Norfolk): a prospective population study. *Ann Epidemiol.* 2006; 16:492–500. [PubMed: 16005244]
54. Fan VS, Au DH, McDonnell MB, Fihn SD. Intraindividual change in SF-36 in ambulatory clinic primary care patients predicted mortality and hospitalizations. *J Clin Epidemiol.* 2004; 57:277–283. [PubMed: 15066688]
55. Bruce B, Fries JF, Hubert H. Regular vigorous physical activity and disability development in healthy overweight and normal-weight seniors: a 13-year study. *Am J Public Health.* 2008; 98:1294–1299. [PubMed: 18511724]
56. Myint PK, Luben RN, Surtees PG, Wainwright NW, Welch AA, Bingham SA, et al. Self-reported mental health-related quality of life and mortality in men and women in the European Prospective Investigation into Cancer (EPIC-Norfolk): a prospective population study. *Psychosom Med.* 2007; 69:410–414. [PubMed: 17585062]
57. Law, S.; Flood, C.; Gagnon, D. Final Report. Ottawa, Ontario: Canadian Health Services Research Foundation, Canadian Institutes of Health Research under Institute of Health Services and Policy Research; 2008. Listening for Direction III. National consultation on health services and policy issues 2007–2010.
58. Chida Y, Steptoe A. Positive psychological well-being and mortality: a quantitative review of prospective observational studies. *Psychosom Med.* 2008; 70:741–756. [PubMed: 18725425]
59. Barnett S, Franks P. Deafness and mortality: analyses of linked data from the National Health Interview Survey and National Death Index. *Public Health Rep.* 1999; 114:330–336. [PubMed: 10501133]
60. Appollonio I, Carabellese C, Magni E, Frattola L, Trabucchi M. Sensory impairments and mortality in an elderly community population: a six-year follow-up study. *Age Ageing.* 1995; 24:30–36. [PubMed: 7762459]

61. Appollonio I, Carabellese C, Frattola L, Trabucchi M. Effects of sensory aids on the quality of life and mortality of elderly people: a multivariate analysis. *Age Ageing*. 1996; 25:89–96. [PubMed: 8670534]
62. Millar WJ. Hearing problems among seniors. *Health Rep*. 2005; 16:49–52. [PubMed: 16190325]
63. Reuben DB, Mui S, Damesyn M, Moore AA, Greendale GA. The prognostic value of sensory impairment in older persons. *J Am Geriatr Soc*. 1999; 47:930–935. [PubMed: 10443852]
64. Lee DJ, Gomez-Marín O, Lam BL, Zheng DD, Arheart KL, Christ SL, et al. Severity of concurrent visual and hearing impairment and mortality: the 1986–1994 National Health Interview Survey. *J Aging Health*. 2007; 19:382–396. [PubMed: 17496240]
65. Lam BL, Lee DJ, Gomez-Marín O, Zheng DD, Caban AJ. Concurrent visual and hearing impairment and risk of mortality: the National Health Interview Survey. *Arch Ophthalmol*. 2006; 124:95–101. [PubMed: 16401790]
66. Klein R, Klein BE, Moss SE. Age-related eye disease and survival. The Beaver Dam Eye Study. *Arch Ophthalmol*. 1995; 113:333–339. [PubMed: 7887847]
67. Laforce RG, Spector WD, Sternberg J. The relationship of vision and hearing impairment to one-year mortality and functional decline. *J Aging Health*. 1992; 4:126–148.
68. Lin MY, Gutierrez PR, Stone KL, Yaffe K, Ensrud KE, Fink HA, et al. Vision impairment and combined vision and hearing impairment predict cognitive and functional decline in older women. *J Am Geriatr Soc*. 2004; 52:1996–2002. [PubMed: 15571533]
69. Rudberg MA, Furner SE, Dunn JE, Cassel CK. The relationship of visual and hearing impairments to disability: an analysis using the longitudinal study of aging. *J Gerontol*. 1993; 48:M261–M265. [PubMed: 8227996]
70. Crews JE, Campbell VA. Vision impairment and hearing loss among community-dwelling older Americans: implications for health and functioning. *Am J Public Health*. 2004; 94:823–829. [PubMed: 15117707]
71. Dalton DS, Cruickshanks KJ, Klein BE, Klein R, Wiley TL, Nondahl DM. The impact of hearing loss on quality of life in older adults. *Gerontologist*. 2003; 43:661–668. [PubMed: 14570962]
72. Ayis S, Gooberman-Hill R, Bowling A, Ebrahim S. Predicting catastrophic decline in mobility among older people. *Age Ageing*. 2006; 35:382–387. [PubMed: 16638760]
73. de Beurs E, Beekman AT, Deeg DJ, Van DR, van TW. Predictors of change in anxiety symptoms of older persons: results from the Longitudinal Aging Study Amsterdam. *Psychol Med*. 2000; 30:515–527. [PubMed: 10883708]
74. Brennan, S.; Gombac, I.; Sleightholm, M. Participation and Activity Limitation Survey 2006 facts on hearing limitations. Ottawa: Statistics Canada; 2009. Fact Sheet.
75. Uhlmann RF, Larson EB, Rees TS, Koepsell TD, Duckert LG. Relationship of hearing impairment to dementia and cognitive dysfunction in older adults. *JAMA*. 1989; 261:1916–1919. [PubMed: 2926927]
76. Lin FR, Metter EJ, O'Brien RJ, Resnick SM, Zonderman AB, Ferrucci L. Hearing loss and incident dementia. *Arch Neurol*. 2011; 68:214–220. [PubMed: 21320988]
77. Gates GA, Anderson ML, McCurry SM, Feeney MP, Larson EB. Central auditory dysfunction as a harbinger of Alzheimer dementia. *Arch Otolaryngol Head Neck Surg*. 2011; 137:390–395. [PubMed: 21502479]
78. Viljanen A, Kaprio J, Pyrkko I, Sorri M, Koskenvuo M, Rantanen T. Hearing acuity as a predictor of walking difficulties in older women. *J Am Geriatr Soc*. 2009; 57:2282–2286. [PubMed: 19874410]
79. Viljanen A, Kaprio J, Pyrkko I, Sorri M, Pajala S, Kauppinen M, et al. Hearing as a predictor of falls and postural balance in older female twins. *J Gerontol A Biol Sci Med Sci*. 2009; 64:312–317. [PubMed: 19182227]
80. Barrett-Connor E, Weiss TW, McHorney CA, Miller PD, Siris ES. Predictors of falls among postmenopausal women: results from the National Osteoporosis Risk Assessment (NORA). *Osteoporos Int*. 2009; 20:715–722. [PubMed: 18797811]
81. Schneider J, Gopinath B, Karpa MJ, McMahon CM, Rochtchina E, Leeder SR, et al. Hearing loss impacts on the use of community and informal supports. *Age Ageing*. 2010; 39:458–464. [PubMed: 20516258]

82. Zhan W, Cruickshanks KJ, Klein BE, Klein R, Huang GH, Pankow JS, et al. Generational differences in the prevalence of hearing impairment in older adults. *Am J Epidemiol*. 2010; 171:260–266. [PubMed: 20008889]
83. McMahon CM, Kifley A, Rochtchina E, Newall P, Mitchell P. The contribution of family history to hearing loss in an older population. *Ear Hear*. 2008; 29:578–584. [PubMed: 18469720]
84. Ives DG, Bonino P, Traven ND, Kuller LH. Characteristics and comorbidities of rural older adults with hearing impairment. *J Am Geriatr Soc*. 1995; 43:803–806. [PubMed: 7602037]
85. Andersson HI. Increased mortality among individuals with chronic widespread pain relates to lifestyle factors: a prospective population-based study. *Disabil Rehabil*. 2009; 31:1980–1987. [PubMed: 19874076]
86. Nondahl DM, Cruickshanks KJ, Wiley TL, Tweed TS, Klein R, Klein BE. Accuracy of self-reported hearing loss. *Audiology*. 1998; 37:295–301. [PubMed: 9776206]
87. Gomez MI, Hwang SA, Sobotova L, Stark AD, May JJ. A comparison of self-reported hearing loss and audiometry in a cohort of New York farmers. *J Speech Lang Hear Res*. 2001; 44:1201–1208. [PubMed: 11776358]
88. Sindhusake D, Mitchell P, Smith W, Golding M, Newall P, Hartley D, et al. Validation of self-reported hearing loss. The Blue Mountains Hearing Study. *Int J Epidemiol*. 2001; 30:1371–1378. [PubMed: 11821349]
89. Chou R, Dana T, Bougatsos C, Fleming C, Beil T. Screening adults aged 50 years or older for hearing loss: a review of the evidence for the U.S. preventive services task force. *Ann Intern Med*. 2011; 154:347–355. [PubMed: 21357912]
90. Barr RD, Chalmers D, De PS, Furlong W, Weitzman S, Feeny D. Health-related quality of life in survivors of Wilms' tumor and advanced neuroblastoma: a cross-sectional study. *J Clin Oncol*. 2000; 18:3280–3287. [PubMed: 10986061]
91. Van Ness PH, Charpentier PA, Ip EH, Leng X, Murphy TE, Tooze JA, et al. Gerontologic biostatistics: the statistical challenges of clinical research with older study participants. *J Am Geriatr Soc*. 2010; 58:1386–1392. [PubMed: 20533963]
92. Woodcock K, Pole JD. Educational attainment, labour force status and injury: a comparison of Canadians with and without deafness and hearing loss. *Int J Rehabil Res*. 2008; 31:297–304. [PubMed: 19008678]
93. Palmer KT, Harris EC, Coggon D. Chronic health problems and risk of accidental injury in the workplace: a systematic literature review. *Occup Environ Med*. 2008; 65:757–764. [PubMed: 18417559]
94. Arlinger S. Negative consequences of uncorrected hearing loss: a review. *Int J Audiol*. 2003; 42:2S17–2S20. [PubMed: 12918624]
95. Mulrow CD, Aguilar C, Endicott JE, Velez R, Tuley MR, Charlip WS, et al. Association between hearing impairment and the quality of life of elderly individuals. *J Am Geriatr Soc*. 1990; 38:45–50. [PubMed: 2295767]
96. Velanovich V. Behavior and analysis of 36-item Short-Form Health Survey data for surgical quality-of-life research. *Arch Surg*. 2007; 142:473–477. [PubMed: 17515490]
97. Weinstein BE, Ventry IM. Hearing impairment and social isolation in the elderly. *J Speech Hear Res*. 1982; 25:593–599. [PubMed: 7162161]
98. Yueh B, Shapiro N, MacLean CH, Shekelle PG. Screening and management of adult hearing loss in primary care: scientific review. *JAMA*. 2003; 289:1976–1985. [PubMed: 12697801]
99. Kramer SE, Kapteyn TS, Kuik DJ, Deeg DJ. The association of hearing impairment and chronic diseases with psychosocial health status in older age. *J Aging Health*. 2002; 14:122–137. [PubMed: 11892756]
100. Strawbridge WJ, Wallhagen MI, Shema SJ, Kaplan GA. Negative consequences of hearing impairment in old age: a longitudinal analysis. *Gerontologist*. 2000; 40:320–326. [PubMed: 10853526]
101. Chisolm TH, Johnson CE, Danhauer JL, Portz LJ, Abrams HB, Lesner S, et al. A systematic review of health-related quality of life and hearing aids: final report of the American Academy of Audiology Task Force On the Health-Related Quality of Life Benefits of Amplification in Adults. *J Am Acad Audiol*. 2007; 18:151–183. [PubMed: 17402301]

102. Ikeda N, Murray CJ, Salomon JA. Tracking population health based on self-reported impairments: trends in the prevalence of hearing loss in US adults, 1976–2006. *Am J Epidemiol*. 2009; 170:80–87. [PubMed: 19451176]
103. Lin FR, Thorpe R, Gordon-Salant S, Ferrucci L. Hearing loss prevalence and risk factors among older adults in the United States. *J Gerontol A Biol Sci Med Sci*. 2011; 66:582–590. [PubMed: 21357188]
104. Cheng AK, Niparko JK. Cost-utility of the cochlear implant in adults: a meta-analysis. *Arch Otolaryngol Head Neck Surg*. 1999; 125:1214–1218. [PubMed: 10555692]
105. Francis HW, Chee N, Yeagle J, Cheng A, Niparko JK. Impact of cochlear implants on the functional health status of older adults. *Laryngoscope*. 2002; 112:1482–1488. [PubMed: 12172266]
106. Damen GW, Beynon AJ, Krabbe PF, Mulder JJ, Mylanus EA. Cochlear implantation and quality of life in postlingually deaf adults: long-term follow-up. *Otolaryngol Head Neck Surg*. 2007; 136:597–604. [PubMed: 17418258]
107. Mulrow CD, Aguilar C, Endicott JE, Tuley MR, Velez R, Charlip WS, et al. Quality-of-life changes and hearing impairment. A randomized trial. *Ann Intern Med*. 1990; 1(113):188–194. [PubMed: 2197909]
108. Yueh B, Souza PE, McDowell JA, Collins MP, Loovis CF, Hedrick SC, et al. Randomized trial of amplification strategies. *Arch Otolaryngol Head Neck Surg*. 2001; 127:1197–1204. [PubMed: 11587599]
109. Stark P, Hickson L. Outcomes of hearing aid fitting for older people with hearing impairment and their significant others. *Int J Audiol*. 2004; 43:390–398. [PubMed: 15515638]
110. Hawkins K, Bottone FG Jr, Ozminkowski RJ, Musich S, Bai M, Migliori RJ, et al. The prevalence of hearing impairment and its burden on the quality of life among adults with Medicare Supplement Insurance. *Qual Life Res*. 2011 [Epub ahead of print].

What is new?**Key message**

Health-related quality-of-life instruments, including hearing and pain, predict mortality (controlling for standard risk factors and health determinants).

What does this study add?

This is the first evidence that two important quality-of-life issues, hearing and pain, predict mortality.

Results also confirm that self-reported mobility predicts mortality.

Implications—what should change now?

These results suggest that more proactive interventions to improve hearing and pain might improve quality-adjusted survival.

Table 1**HUI3: health-status classification system**

Attribute	Level	Description
Vision	1	Able to see well enough to read ordinary newsprint and recognize a friend on the other side of the street, without glasses or contact lenses.
	2	Able to see well enough to read ordinary newsprint and recognize a friend on the other side of the street but with glasses.
	3	Able to read ordinary newsprint with or without glasses but unable to recognize a friend on the other side of the street, even with glasses.
	4	Able to recognize a friend on the other side of the street with or without glasses but unable to read ordinary newsprint, even with glasses.
	5	Unable to read ordinary newsprint and unable to recognize a friend on the other side of the street, even with glasses.
	6	Unable to see at all.
Hearing	1	Able to hear what is said in a group conversation with at least three other people, without a hearing aid.
	2	Able to hear what is said in a conversation with one other person in a quiet room without a hearing aid but requires a hearing aid to hear what is said in a group conversation with at least three other people.
	3	Able to hear what is said in a conversation with one other person in a quiet room with a hearing aid and able to hear what is said in a group conversation with at least three other people, with a hearing aid.
	4	Able to hear what is said in a conversation with one other person in a quiet room, without a hearing aid but unable to hear what is said in a group conversation with at least three other people even with a hearing aid.
	5	Able to hear what is said in a conversation with one other person in a quiet room with a hearing aid but unable to hear what is said in a group conversation with at least three other people even with a hearing aid.
	6	Unable to hear at all.
Speech	1	Able to be understood completely when speaking with strangers or friends.
	2	Able to be understood partially when speaking with strangers but able to be understood completely when speaking with people who know me well.
	3	Able to be understood partially when speaking with strangers or people who know me well.
	4	Unable to be understood when speaking with strangers but able to be understood partially by people who know me well.
	5	Unable to be understood when speaking to other people (or unable to speak at all).
Ambulation	1	Able to walk around the neighborhood without difficulty and without walking equipment.
	2	Able to walk around the neighborhood with difficulty but does not require walking equipment or the help of another person.
	3	Able to walk around the neighborhood with walking equipment but without the help of another person.
	4	Able to walk only short distances with walking equipment and requires a wheelchair to get around the neighborhood.
	5	Unable to walk alone, even with walking equipment. Able to walk short distances with the help of another person and requires a wheelchair to get around the neighborhood.
	6	Cannot walk at all.
Dexterity	1	Full use of 2 hands and 10 fingers.
	2	Limitations in the use of hands or fingers but does not require special tools or help of another person.
	3	Limitations in the use of hands or fingers and is independent with use of special tools (does not require the help of another person).
	4	Limitations in the use of hands or fingers and requires the help of another person for some tasks (not independent even with use of special tools).
	5	Limitations in use of hands or fingers and requires the help of another person for most tasks (not independent even with use of special tools).
	6	Limitations in use of hands or fingers and requires the help of another person for all tasks (not independent even with use of special tools).
Emotion	1	Happy and interested in life.

Attribute	Level	Description
Cognition	2	Somewhat happy.
	3	Somewhat unhappy.
	4	Very unhappy.
	5	So unhappy that life is not worthwhile.
	1	Able to remember most things, think clearly, and solve day-to-day problems.
	2	Able to remember most things but have a little difficulty when trying to think and solve day-to-day problems.
	3	Somewhat forgetful but able to think clearly and solve day-to-day problems.
	4	Somewhat forgetful and have a little difficulty when trying to think or solve day-to-day problems.
	5	Very forgetful and have great difficulty when trying to think or solve day-to-day problems.
	6	Unable to remember anything at all and unable to think or solve day-to-day problems.
Pain	1	Free of pain and discomfort.
	2	Mild-to-moderate pain that prevents no activities.
	3	Moderate pain that prevents a few activities.
	4	Moderate-to-severe pain that prevents some activities.
	5	Severe pain that prevents most activities.

Abbreviation: HUI3, Health Utilities Index Mark 3.

Source ref. [14], p. 124.

Table 2Demographic characteristics of the baseline 1994/95 sample ($n = 12,375$ for 18+, $m = 3,575$ for 60+)

Demographic characteristics	For 18+		For 60 +	
	<i>N^a</i>	<i>%^b</i>	<i>N^a</i>	<i>%^b</i>
Age				
18–29	2,594	22		
30–39	2,854	25		
40–49	2,194	20		
50–59	1,631	14		
60–69	1,452	11	1,655	51
70–79	1,163	7	1,340	36
80+	487	2	580	13
Sex				
Male	5,518	48	1,446	44
Female	6,857	52	2,129	56
Marital status				
Single	2,737	21	263	6
Married	7,063	65	1,816	63
Widowed	1,239	6	1,218	25
Separated/divorced	1,336	8	278	6
Immigrant status				
Nonimmigrants	10,663	81	2,906	75
Immigrants	1,712	19	664	25
Income				
Lowest	2,760	17	1,100	23
Lower middle	3,661	29	1,353	38
Upper middle	4,092	35	755	26
Highest	1,420	15	175	7
Missing	442	4	192	6
Education				
Less than high school	3,582	25	1,928	50
High school graduation	1,903	16	419	13
Completed or currently enrolled in college/university	6,890	58	1,215	36
Residential environment				
Urban	9,342	83	2,602	82
Rural	3,033	17	973	18
SRH				
Excellent	2,828	26	440	14
Very good	4,628	37	1,014	28
Good	3,333	27	1,133	34
Fair	1,236	8	695	19
Poor	350	2	215	6

Abbreviation: SRH, self-rated health.

^a n is the unweighted sample size.

^b Percentage (%) is the weighted proportion.

\$watermark-text

\$watermark-text

\$watermark-text

Table 3

Frequency distribution (%) of HUI3 attribute levels for all respondents, $n = 12,375$ for 18+; $n = 3,575$ for 60+ in parentheses

Levels	Vision	Hearing	Speech	Ambulation	Dexterity	Emotion	Cognition	Pain
1	45.7 (14.1)	95.3 (85.6)	99.1 (98.2)	96.7 (88.7)	98.9 (97.8)	74.6 (74.7)	69.2 (63.7)	82.2 (71.5)
2	51.7 (79.5)	2.3 (6.1)	0.7 (1.1) ^a	0.8 (1.9)	0.7 ^b (1.3) ^a	22.4 (21.3)	17.0 (21.4)	5.5 (6.5)
3	0.7 (1.7)	0.5 (2.6)	0.3 ^b	1.7 (5.9)		2.2 (3.0) ^a	5.5 (4.0)	5.9 (10.1)
4	1.3 (2.7)	1.5 (3.7)		0.6 ^b (2.6) ^a	0.4 ^b	0.5	6.4 (7.9)	3.5 (5.9)
5	0.6 ^b (1.5)	0.5 ^b (1.2)				0.3	2.1 ^b (2.6)	2.9 (6.1)
6			n/a	0.2		n/a		n/a

Abbreviation: n/a: not applicable.

Weighted frequency (frequencies within each attribute levels do not necessarily add up to a total because of rounding of weighted frequencies).

^aLevels 2–6 for speech and dexterity, levels 5 and 6 for ambulation, and levels 3–5 for emotion.

^bLevels were collapsed because of confidentiality concerns.

\$watermark-text

\$watermark-text

\$watermark-text

Table 4

Relative hazard of death by selected HUI3 attributes for 18+ and 60+ at baseline

Hazard ratio	Hearing 18+	Hearing 60+	Ambulation 18+	Ambulation 60+	Pain 18+
0.18 (0.06–0.57) ^a	18,721	12,491	0.10 (0.04–0.23) ^b	0.11 (0.04–0.30) ^c	0.53 (0.29–0.96) ^c
–2LL (df = 38); <i>P</i> < 0.05			18,704	12,483	18,723

Abbreviations: –2LL, twice negative log likelihood; df, degree of freedom.

Complete results are reported in Tables A1 and A2 (for 18+ and 60+, respectively).

^a *P* < 0.01.
^b *P* < 0.001.
^c *P* < 0.05.

Table 5

Simulations of the effects of each level for hearing, ambulation, and pain on the relative risk of mortality based on results for 18+; simulations for hearing and ambulation based on results for 60+ in parentheses

Level	Hearing	Ambulation	Pain
1	1.00 (1.00)	1.00 (1.00)	1.00
2	1.27 (1.31)	1.48 (1.45)	1.05
3	1.63 (1.76)	2.15 (2.06)	1.16
4	2.41 (2.75)	4.41 (4.07)	1.39
5	3.16 (3.76)	7.02 (6.30)	1.89
6	5.44 (7.00)	10.12 (8.95)	n/a

Note: For hearing, ambulation, and pain level 1, no disability; level 2, mild disability; level 3, moderate disability (as does level 4, for hearing); levels 5 and 6, severe disability for hearing; levels 4–6, severe disability for ambulation; and levels 4 and 5, severe disability for pain.