US Trends in Quality-Adjusted Life Expectancy From 1987 to 2008: Combining National Surveys to More Broadly Track the Health of the Nation

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Objectives. We used data from multiple national health surveys to systematically track the health of the US adult population.

Methods. We estimated trends in quality-adjusted life expectancy (QALE) from 1987 to 2008 by using national mortality data combined with data on symptoms and impairments from the National Medical Expenditure Survey (1987), National Health Interview Survey (1987, 1994–1995, 1996), Medical Expenditure Panel Survey (1992, 1996, 2000–2008), National Nursing Home Survey (1985, 1995, and 1999), and Medicare Current Beneficiary Survey (1992, 1994–2008). We decomposed QALE into changes in life expectancy, impairments, symptoms, and smoking and body mass index.

Results. Years of QALE increased overall and for all demographic groups—men, women, Whites, and Blacks—despite being slowed by increases in obesity and a rising prevalence of some symptoms and impairments. Overall QALE gains were large: 2.4 years at age 25 years and 1.7 years at age 65 years.

Conclusions. Understanding and consistently tracking the drivers of QALE change is central to informed policymaking. Harmonizing data from multiple national surveys is an important step in building this infrastructure. (*Am J Public Health.* Published online ahead of print September 12, 2013: e1–e10. doi:10.2105/AJPH.2013.301250)

Despite tremendous expenditures on medical care and public health in the United States, there has not been a systematic effort to measure the overall impact of spending on population health. Without a comprehensive population health measure, we cannot track health changes in conjunction with changes in medical treatment and public health practices, or systematically consider the impact of possible interventions.[1–4] Thus, ongoing measurement of the health of the nation has been recommended by multiple commissions and panels.[5,6,7]

Essential attributes of a national population health measure are that it is detailed, combines mortality and morbidity into a single metric, is consistent over time, and provides information on the entire US population.[1–4] It should also extend beyond disease and consider both physical and mental functioning and well-being.[8,9] Length of life is tracked consistently in the United States.[10] However, the measurement of health-related quality of life (HRQOL) is fragmented. The HRQOL instruments that combine groups of questions on functioning and symptoms into a general health score—for example the EuroQol-5D (EQ-5D),[11] Short Form-6D,[12] Health Utilities Index,[13] Quality of Well-Being[14,15]—have rarely been included in multiple years of US national surveys. Scores on existing instruments have been imputed in national data in some years,[9,16] and broader self-rated health questions have been used over a longer period of time.[17] A measure that combines self-care ability with an overall health rating (the Health and Activity Limitation Index) was also proposed for use in health tracking.[18] However these measures do not take advantage of the rich data covering multiple dimensions of health, have sometimes trended in different directions across national surveys,[19] and do not provide specific and actionable information on the particular symptoms and impairments underlying health change.[9]

Population coverage has also been incomplete; although some studies of health trends in the elderly have included those in institutions,[20–24] most have not. Finally, in tracking health, it is important to examine disparities across demographic groups, which are known to differ in morbidity and mortality rates,[25,26] and to take into account the effects of differences in behavioral risk factors, particularly obesity and smoking, which have been found to have the largest effects on mortality.[27,28]

Our goal was to examine US trends in quality-adjusted life expectancy (QALE) using as rich a set of health indicators as possible in as broad a population as possible and to parse out the major factors driving changes in health over time: changes in mortality, changes in the prevalence of symptoms and impairments, and changes in obesity and smoking. We used data for the community and the institutionalized populations aged 25 years and older from 1987, 1994–1995, and 2000–2008 to track and disaggregate QALE.

METHODS

We defined health as the remaining quality-adjusted years of life a typical person of a given age can expect to live.[29] We considered changes in QALE for a typical 25-year-old person and a typical 65-year-old person.

Data

For life expectancy, we used national reports of mortality rates at each age.[10,30] Data for HRQOL were from multiple sources: the National Medical Expenditure Survey (1987), the National Health Interview Survey (1987, 1994–1995, 1996), the Medical Expenditure Panel Survey (1992, 1996, 2000–2008), the National Nursing Home Survey (1985, 1995, and 1999) and institutionalized respondents to the Medicare Current Beneficiary Survey (1992, 1994–2008). Data on smoking and

TABLE 1—Symptoms and Impairments Comparable Over Time: United States, 1987–2008

	Community Population			Institutionalized Population	
Domain	1987 NMES or NHIS^a	1994 and 1995 NHIS	2000–2008 MEPS	1985, 1995, 1999 NNHS	1994–2008 MCBS
Primary activity	Major, social	Major, social	Major, social	. . .	Social
Physical activity	Self-care, routine needs, bending, lifting, walking	Self-care, routine needs, bending, lifting, walking, standing, reaching, dexterity	Self-care, routine needs, bending, lifting, walking, standing, reaching, dexterity	Self-care, routine needs, bending, lifting, walking	Self-care, routine needs, bending, lifting, walking, reaching, dexterity
Mental	Depressive, anxious	. . .	Depressive, anxious	. . .	. . .
Sensory	Vision, hearing	. . .	Vision, hearing	Vision, hearing	Vision, hearing
Pain	. . .	. . .	Pain interfered with normal work	. . .	. . .
Cognitive	. . .	. . .	Cognitive impairment	. . .	. . .
Energy	. . .	. . .	Low energy	. . .	. . .

Note. MCBS = Medicare Current Beneficiary Survey; MEPS = Medical Expenditure Panel Survey; NHIS = National Health Interview Survey; NMES = National Medical Expenditure Survey; NNHS = National Nursing Home Survey. Details on the wording of each survey's symptom and impairment questions, along with a discussion of cross-survey differences and adjustments performed to address them, are provided in the appendix (available as a supplement to the online version of this article at http://www.ajph.org).

[a] NHIS 1987, 1994–1995, and 1996 used for primary activity limitation, self-care (activities of daily living), and routine needs (instrumental activities of daily living).

body mass index (BMI; defined as weight in kilograms divided by the square of height in meters) were from the National Health and Nutrition Examination Survey (NHANES; 1988–1994, 2000–2008). We weighted all surveys to be representative of the US population (surveys described in the appendix, available as a supplement to the online version of this article at http://www.ajph.org). Because many of the HRQOL indicators were designed for the adult population, we restricted analyses to individuals aged 25 years or older.

We grouped symptoms and impairments into 7 broad domains: problems with primary activity (working, keeping house, school) or social activity; physical activity limitations (self-care, performance of tasks for routine needs, and specific movement difficulties); mental health symptoms; sensory problems (vision and hearing impairment); pain; cognitive impairment and low energy. Table 1 provides a list of comparable symptoms and impairments measured in each survey. The appendix provides details on the samples, the wording of each survey's symptom and impairment questions, and the disutility weights assigned to them. The appendix also discusses cross-survey differences and adjustments performed to address them.

Health Related Quality of Life and Quality Adjusted Life Expectancy Calculation

We calculated HRQOL scores based on 2 considerations: the prevalence of particular symptoms and impairments in the population (measured at several points in time) and the impact of each impairment and symptom on HRQOL (calculated at a single point in time). To estimate the impact of symptoms and impairments on HRQOL, we used a previously published method[31] to relate each symptom and impairment to a 100-point rating of overall health (the visual analog scale from the EQ-5D[11]) measured in the 2002 Medical Expenditure Panel Survey. We then calculated disutility weights for each impairment and symptom independent of the others. Weights not only are based on the coefficients for the main effects but also reflect the effects of interactions between all pairs of symptoms and impairments. To do this, we calculated mean predicted scores from the regressions, first assuming that everyone reported the item (worst case) and then assuming no one reported the item (best case). The difference between these mean predicted scores yields a weight that captures the broadest possible impact of having the symptom or impairment in light of the other symptoms and impairments that people have.

To calculate HRQOL scores, we applied these weights to the predicted rates of symptoms and impairments reported by 10-year age group in each year. We also added a decrement equal to the intercept of the regression to all HRQOL scores to represent the average utility loss not accounted for by our set of symptoms and impairments. Previous analyses[31] supported holding constant the impact of each impairment and symptom over time, with changes in the prevalence of symptoms and impairments driving changes in population HRQOL.

To adjust for the fact that more symptoms and impairments were available in the 2000s than in earlier years, we calculated 2 additional HRQOL scores for each 10-year age group in 2000: one using only the symptoms and impairments available in the 1987 National Medical Expenditure Survey, and one using only those in the 1994–1995 National Health Interview Survey. For each 10-year age group, we calculated the difference in 2000 between HRQOL scores using the smaller number of symptoms and impairments versus the larger set. We used this difference to adjust the 1987 and 1994–1995 scores downward by 10-year age group to account for the fact that the scores in those years were based on fewer symptoms and impairments.

To calculate QALE, mean HRQOL for each 10-year age group was used to adjust remaining life expectancy at each age. We used a delta method to estimate standard errors in QALE trends, taking into account the error associated with each of the QALE components.[32]

Disaggregation of Quality-Adjusted Life Expectancy Trends

We disaggregated overall QALE change into 3 contributing factors: changes in mortality not attributable to obesity and smoking trends, changes in the prevalence of each symptom and impairment not attributable to changes in obesity and smoking, and changes in obesity and smoking prevalence.

To estimate the effects of obesity and smoking, we divided the population into 12 cells on the basis of BMI categories (normal weight, overweight, obese, and morbidly obese) and smoking categories (never, former, and current smoker). We estimated the distribution of the population into these categories using NHANES data, smoothing obesity and smoking rates across ages using regression analysis. The first and second phases of NHANES III data (1988–1991 and 1992–1994) were used to estimate rates for 1987 and 1994–1995, respectively, and continuous NHANES data were used for 2000 onward. More details are given in the online appendix.

We calculated the relative risks of mortality for each smoking–BMI category by using combined NHANES I, II, and III mortality follow-up data, analogous to the methodology in Stewart et al.[27] The effect of obesity and smoking changes on life expectancy was the difference between the actual improvement in life expectancy over time and the improvement forecast when holding constant obesity and smoking rates at baseline levels.

To calculate the contribution of life expectancy changes to QALE trends net of the impact of obesity and smoking, we simulated the increase in QALE that would have occurred if neither obesity or smoking nor impairments or symptoms had changed from their baseline rates.

To calculate the impact of obesity and smoking changes on QALE via QOL, we first calculated predicted rates of symptoms and impairments in each 10-year age group and calendar year for each BMI–smoking category. We then simulated QALE changes holding BMI and smoking constant at their base rates. The difference between the simulated and actual QALE, holding constant life expectancy, was the impact of changes in obesity and smoking on QALE change via their effects on HRQOL. Finally, the effect of symptom and impairment change net of obesity and smoking was the simulated QALE change holding constant both life expectancy and smoking and BMI rates.

RESULTS

Table 2 shows rates of reported symptoms and impairments in 1987, 1994–1995, 2000, and 2008 (age-normed to the 2000 population distribution), as well as tests of trends in each impairment and symptom from the first time it was measured. Among those aged 25 to 64 years, only a few symptoms and impairments declined in prevalence, whereas among those aged 65 years and older, the majority of them decreased at least slightly over time. Plots of some of these trends are in the appendix. There were improvements among both age groups in difficulty with major activity, depressive mood, vision, and low energy. However, for difficulty with major activity and vision, there was some reversal of this trend among the nonelderly over the 2000s. Difficulty with walking and routine needs improved significantly only among the elderly, whereas walking problems worsened significantly over the 2000s for the nonelderly. Though anxiety declined dramatically in both age groups from 1987 to 2000, in 2001 there was subsequently a sustained increase in anxiety among young and middle-aged adults versus a slight continued decline among those aged 65 years and older. Increasing among both age groups were difficulty with bending, standing, reaching, dexterity, and cognitive impairment.

Taking account of the changes in all of the symptoms and impairments and their associated disutility weights, HRQOL was essentially unchanged among the nonelderly and increased among the elderly, particularly the oldest old. Men had the highest HRQOL, with similar levels among Blacks and Whites. Black women had the lowest HRQOL. (Plots of HRQOL trends are in the appendix, available as a supplement to the online version of this article at http://www.ajph.org)

Quality Adjusted Life Expectancy Trends

Trends in overall population health (QALE) in 1987, 1994–1995, and 2000–2008 are shown overall and by gender and race in Figure 1 for a typical 25-year-old person (Figure 1a) and a typical 65-year-old person (Figure 1b). Overall, mean QALE rose by 2.4 years, or 6% ($P < .005$) at age 25 years and 1.7 years (14%; $P = .007$) at age 65 years. White women had the highest and Black men the lowest QALE levels. White men had higher levels than Black women at age 25 years but not at age 65 years. Although life expectancy of Black women exceeded that of White men,[10] adjusting for HRQOL reversed this relationship at age 25 years, with higher QALE among White men.

Improvement in QALE occurred among all groups, with a narrowing of gender and race gaps over time, and a greater rate of increase among the elderly. From 1987 to 2008, QALE at age 25 years increased by 1.6 years among White women, 3.0 years among White men, 2.8 years among Black women, and 4.1 years among Black men. At age 65 years, QALE increased by 1.2 years among White women, 2.2 years among White men, 1.7 years among Black women, and 1.8 years among Black men.

Disaggregation of Quality-Adjusted Life Expectancy Trends

The factors underlying increased overall QALE are summarized in Figure 2. Reduced mortality net of obesity and smoking was the major driver of QALE gains among both 25- and 65-year-old persons. Life expectancy improvements alone accounted for 84% (2.2 years) of the QALE increase at age 25 years and 80% (1.5 years) at age 65 years. The next largest drivers of QALE gains were reductions in the prevalence of symptoms and impairments, particularly low energy (accounting for 7% of the QALE increase at age 25 years and 6% at age 65 years), vision problems (3% at both ages), anxiety (3% at age 25 years and 2% at age 65 years), depressive mood (2% at age 25 years and 3% at age 65 years), and primary activity limitation, self-care, routine needs and pain (each accounting for 1%–2% at age 25 years and 3% at age 65 years). Improvements in primary activity, anxiety, and vision increased QALE before 2000, whereas improvements in energy, depression, pain, and self-care increased QALE more recently. Overall, declines in symptoms and impairments accounted for 27% (0.49 years) of the QALE increase at age 25 years, and 22% (0.57 years) at age 65 years.

During this time period, smoking rates declined while obesity rates climbed (Table 2), with some leveling off in recent years; the net effect was to attenuate the gains in QALE by 0.15 years at age 25 years and 0.12 years

TABLE 2—Rates of Symptoms and Impairments and Behavioral Risk Factors Over Time: United States, 1987–2008

	1987 (NMES/NHIS), %	1994–1995 (NHIS), %	2000 (MEPS), %	2008 (MEPS), %	Percentage Point Change	*P*[a]
			Age 25–64 y			
Primary activity						
Major activity	6.6	7.3	5.8	6.3	–0.3	<.001
Social activity	. . .		3.5	3.5	0	.987
Physical activity						
Self-care	0.6	0.4	0.7	0.7	0.1	.587
Routine needs	1.7	1.9	1.6	1.7	0	.011
Walking[b]	4.9	5.1	6.1	6.8	1.9	.107
Bending[c]	. . .	5.1	5.4	6.2	1.1	.273
Lifting	. . .	4.0	3.8	4.0	0	.108
Standing	. . .	4.5	5.1	5.3	0.8	.146
Reaching	. . .	2.2	3.4	3.8	1.6	<.001
Dexterity	. . .	2.2	2.2	2.3	0.1	.785
Mental health						
Depressed mood	29.8	. . .	28.6	25.0	–4.8	<.001
Anxiety	34.3	. . .	27.4	39.5	5.2	<.001
Sensory						
Vision	9.7	. . .	4.1	4.8	–4.9	<.001
Hearing	5.8	. . .	3.6	4.5	–1.3	<.001
Pain	. . .	. . .	41.3	42.1	0.8	.827
Cognitive	. . .	. . .	2.4	3.1	0.7	.238
Low energy	. . .	. . .	54.7	43.5	–11.2	.501
Behavioral risk factors						
Current smoker	32.7	29.0	26.9	26.0	–6.7	<.001
Obese (BMI ≥ 30 kg/m^2)	23.5	26.7	32.6	36.4	12.9	<.001
			Age $\geq$ 65 y			
Primary activity						
Major activity	28.3	28.1	22.6	22.5	–5.8	.604
Social activity	. . .	. . .	11.3	11.1	–0.1	.661
Physical activity						
Self-care	9.7	10.9	10.3	8.6	–1.1	.725
Routine needs	15.8	17.0	14.7	13.6	–2.2	.005
Walking[b]	39.0	30.1	30.5	31.5	–7.5	<.001
Bending[c]	. . .	22.2	26.0	26.6	4.4	.652
Lifting	. . .	19.8	22.0	21.0	1.2	.202
Standing	. . .	22.8	26.1	25.6	2.8	.001
Reaching	. . .	10.7	19.3	18.0	7.2	<.001
Dexterity	. . .	9.0	13.1	11.6	2.6	.961
Mental health						
Depressed mood	34.8	. . .	30.2	28.1	–6.7	<.001
Anxiety	36.6	. . .	25.2	23.9	–12.7	<.001
Sensory						
Vision	28.3	. . .	12.0	10.8	–17.5	<.001
Hearing	21.7	. . .	20.8	20.1	–1.6	.348

Continued

TABLE 2—*Continued*

Pain	. . .	. . .	66.6	64.7	–1.9	.103
Cognitive	. . .	. . .	7.6	9.4	1.8	.032
Low energy	. . .	. . .	69.0	62.7	–6.3	.007
Behavioral risk factors						
Current smoker	12.8	10.4	10.1	8.2	–4.6	<.001
Obese (BMI ≥ 30 kg/m^2)	20.2	24.3	30.1	32.7	12.5	<.001

Note. BMI = body mass index (defined as weight in kilograms divided by the square of height in meters); MEPS = Medical Expenditure Panel Survey; NHIS = National Health Interview Survey; NMES = National Medical Expenditure Survey. Rates of all impairments, symptoms, and behavioral risk factors are shown adjusted to the 2000 population distribution by 10-year age groups. These are predicted rates predicted from regression models by using 10-year age categories, gender, race (Black or White), gender × race, and smoking and BMI categories. Analyses in MEPS (2000–2008) were in pooled data with dummy variables for survey year, interacted with age. Excluded were those of "other" race (not White or Black), those with a BMI less than 18.5, and those with incomplete data on smoking and BMI. In NHIS, where a large portion of the samples (51% in 1987, 74% in 1994–1995) were missing smoking status because of only 1 adult per household being asked about it in a supplement (in all households in 1987 and half of households in 1994–1995), we included a dummy variable for missing on smoking in the regressions to avoid losing data on these individuals. *P* values are for a variable with levels representing years from the time when the symptom or impairment was first measured. We estimated risk factor rates from National Health and Nutrition Examination Survey data.

[a] We tested significance of changes in the noninstitutionalized population by using logistic regressions, controlling for 10-year age group, gender, race, gender × race, BMI category, and BMI–smoking category.

[b] Walking rates excluding difficulty walking a mile. Rates including walking a mile for age 25–64 years were 6.1% in 2000 and 6.8% in 2008 ($P = .005$). For age ≥ 65 years, rates including 1 mile were 30.3% and 31.3% ($P = .665$).

[c] Bending and lifting were asked as part of a combined question in 1987, and rates of these limitations combined were 13% for the nonelderly and 47% for age ≥ 65 years. $P < .001$ for bending or lifting combined from 1987 to 2008, for both ages 25–64 years and ≥ 65 years.

at age 65 years (accounting for –6% of the QALE increase). The effect of these behavioral risk factors on life expectancy was about 3 times their effect on HRQOL at age 25 years and twice their effect on HRQOL at age 65 years.

DISCUSSION

Population health, as measured by QALE in the US community and institutionalized populations, has increased markedly over the past 2 decades. A typical 25-year-old person will live an additional 2.4 quality-adjusted years today compared with a 25-year-old person in 1987, and a 65-year-old person will live an additional 1.7 quality-adjusted years. For both ages, the major factor driving this change was declining mortality, though HRQOL improvements contributed as well. The most important improvements were in energy, depressive mood, self care, pain, and routine needs. Reductions in anxiety and vision problems were important prior to 2000 but have not continued among the nonelderly.

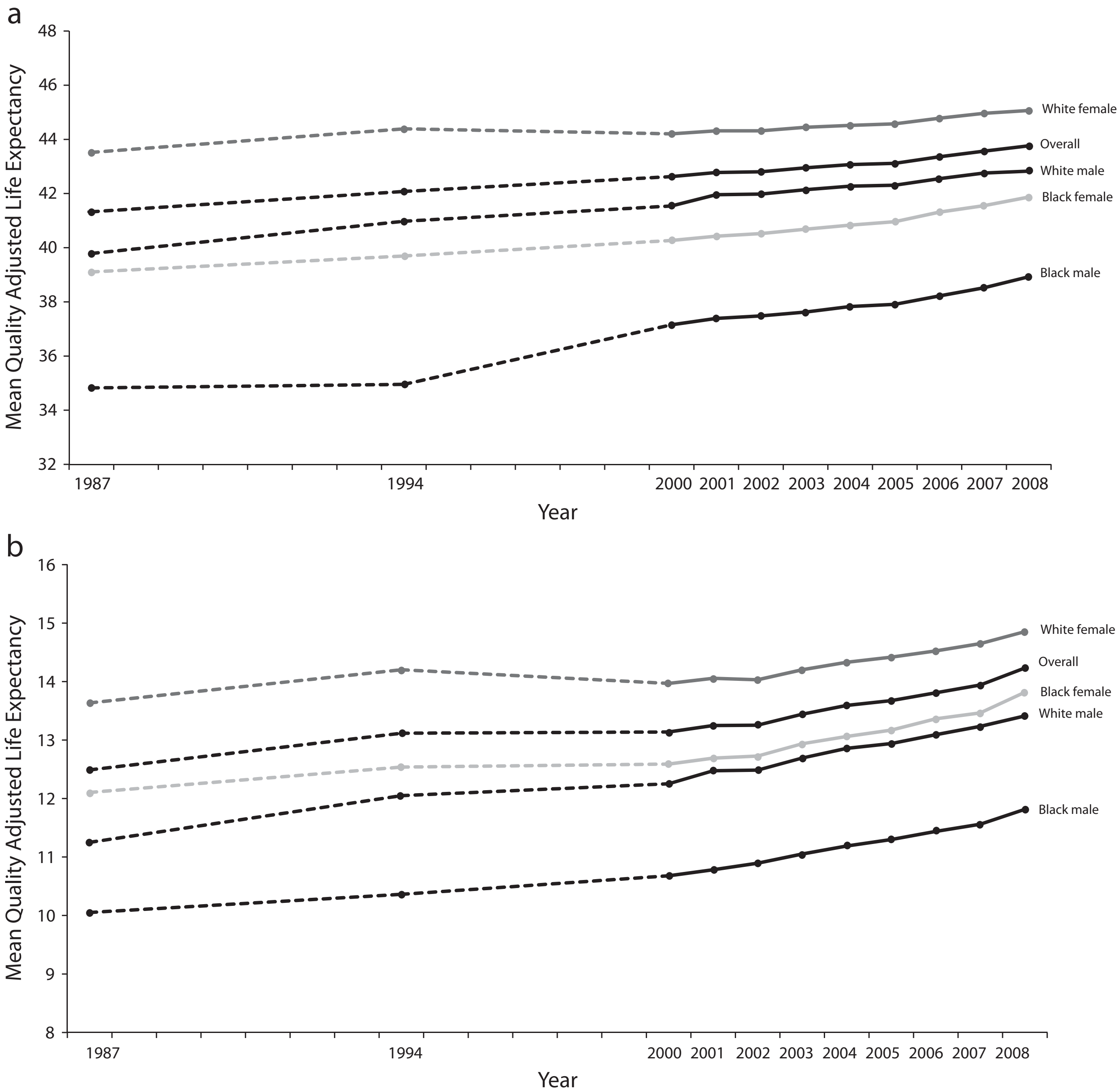
Changes in obesity and smoking rates have also affected QALE. The 1.6-fold increase in obesity since 1987, though counterbalanced by declines in smoking, attenuated the increases in QALE by more than a tenth of a year. The effect was most pronounced from the mid-1990s to 2000, when obesity showed the greatest increase. Still, this was more than offset by other health trends.

Disparities in QALE by gender and race were large, with White women having the highest and Black men the lowest QALE at both age 25 years and 65 years. Consistent with previous findings that women live longer but report worse health than men,[26] both White and Black women had higher life expectancy than men, but lower HRQOL. White and Black men had similar HRQOL levels, whereas the HRQOL of Black women remained lowest across all groups. Adjusting for quality drove the QALE of Black women below that of White men at age 25 years.

Increases in QALE occurred for all groups, and was greater at older ages.[33] Gaps by gender and race narrowed over time as has previously been reported.[34–36] Black male QALE at age 25 years rose dramatically from the mid- to late 1990s, reflecting the end of a mortality spike begun in the 1980s, driven by HIV infection and homicide.[37–39] White women showed the smallest QALE increase at both age 25 years and 65 years, with the literature indicating that their average was held back by increases in mortality among White women who did not complete high school.[34,40,41] The continued disparities and the fact that the narrowing of the gap was partially attributable to worsening health among Whites is disconcerting. Combined with the fact that US life expectancy lags behind that of some other countries, this underlies the importance of examining and addressing the factors underlying health disparities.[42,43]

This is the first study to assess detailed US QALE trends spanning 3 decades and to disaggregate them into the underlying symptoms and impairments. A recent study[16] of the noninstitutionalized US adult population, mapping EQ-5D scores from Behavioral Risk Factor Surveillance System data on self-rated health and healthy days, found a QALE increase of 1.1 years at age 18 years from 1993 to 2008, with worsening HRQOL over time[17] offset by increases in longevity. By contrast, we found essentially no change in HRQOL over this time period among the nonelderly and some improvement among the elderly when we used a more detailed set of symptoms and impairments. One difference underlying these findings may be that self-reports of general health have declined in some surveys,[16,17,19] while many other measures of symptoms and impairments have remained constant or improved, particularly among the elderly.

Several studies have examined changes in particular symptoms and impairments over parts of this time period, and our findings are largely consistent with these. Similar to studies of disability in activities of daily living and instrumental activities of daily living, we found declines in difficulty with self-care and routine

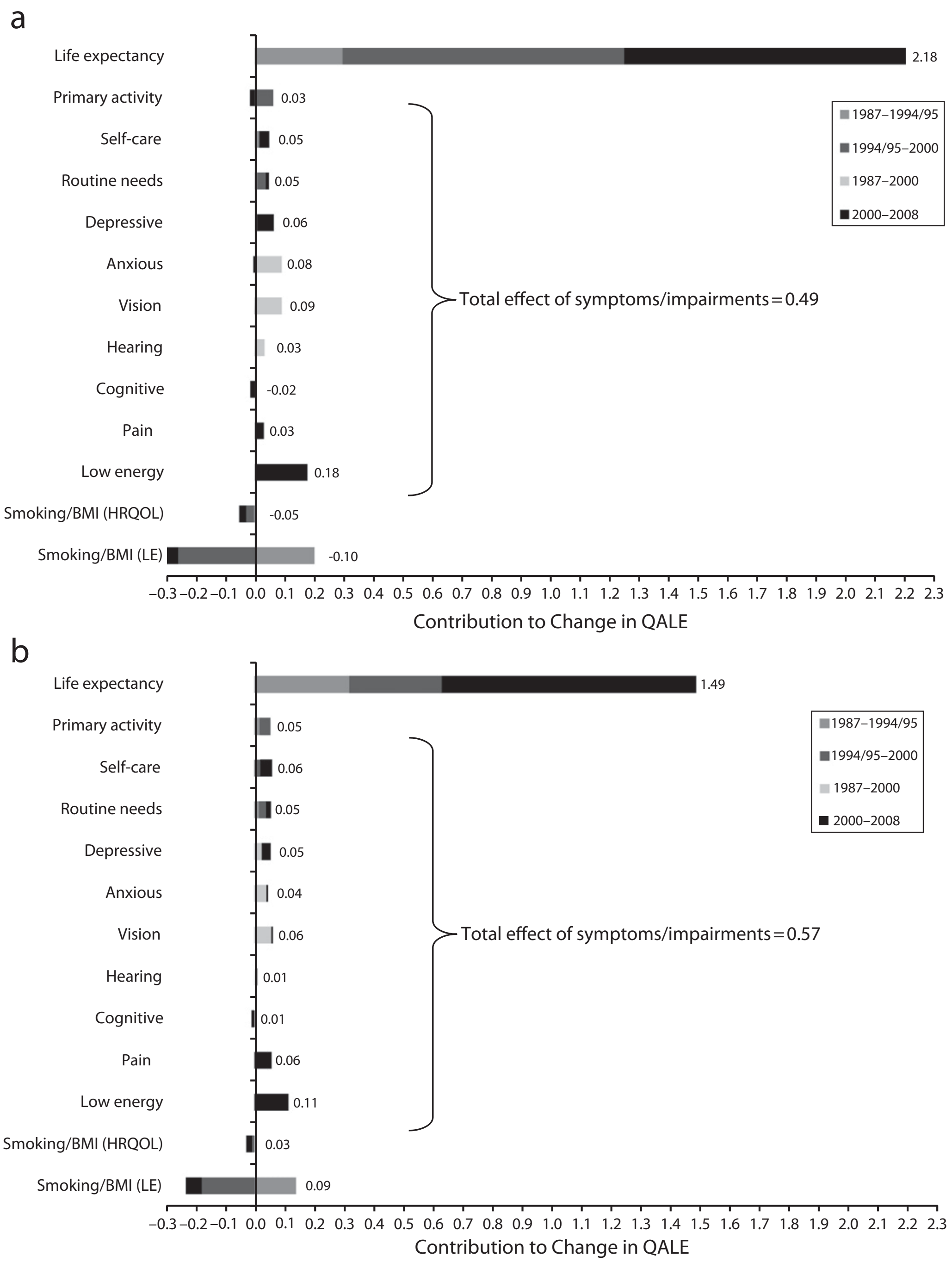


Note. Dotted lines indicate that data was not available for intervening years. The 95% confidence intervals for overall change are smaller than the width of the line. All trends exclude those of “other” race (not White or Black).

Source. National mortality data combined with data on symptoms and impairments from the National Medical Expenditure Survey (1987), National Health Interview Survey (1987, 1994–1995, 1996), Medical Expenditure Panel Survey (1992, 1996, 2000–2008), National Nursing Home Survey (1985, 1995, and 1999), and Medicare Current Beneficiary Survey (1992, 1994–2008).

FIGURE 1—Trends in quality-adjusted life expectancy at (a) age 25 years and (b) age 65 years: United States, 1987–2008.

needs among the elderly,[20,21] but not among those younger than 65 years.[44–46] Also, consistent with studies finding declines in hearing problems[47] and some increases in mobility problems since the mid-1990s, we found reductions in hearing problems and increases in reported problems with walking (among the nonelderly), and with bending, standing, and reaching over this period.[44,48] This is congruent with increases in disability that have been found among the working-age population, partially explained by rising obesity and chronic disease.[46] The decline in depressive and anxiety symptoms is concurrent with the increase in pharmaceutical treatment of these



Note. BMI = body mass index (defined as weight in kilograms divided by the square of height in meters); HRQOL = health-related quality of life; LE = life expectancy; QALE = quality-adjusted life expectancy. Each bar shows the contribution of that factor to improved population health, holding constant the other contributors to population health. For example, changes in life expectancy held constant the health-related quality of life and share of people in different weight and smoking categories. Obesity or smoking compared the gap between QALE change when allowing behavioral risk factors to change versus holding them constant. Symptoms and impairments explaining less than 0.02 years of QALE change at age 25 years are not shown in either figure: social activity, walking, lifting, bending, standing, reaching, and dexterity.

Source. National mortality data combined with data on symptoms and impairments from the National Medical Expenditure Survey (1987), National Health Interview Survey (1987, 1994–1995, 1996), Medical Expenditure Panel Survey (1992, 1996, 2000–2008), National Nursing Home Survey (1985, 1995, and 1999), and Medicare Current Beneficiary Survey (1992, 1994–2008).

FIGURE 2—Factors accounting for changes in quality-adjusted life expectancy from 1987 to 2008 at (a) age 25 years (total improvement = 2.4 y) and (b) age 65 years (total improvement = 1.7 y): United States, 1987–2008.

mental health conditions since the advent of serotonin-reuptake inhibitors in the late 1980s[49]; however, there is debate about the efficacy level of these medications.[50] Furthermore, anxiety declines have not continued among the nonelderly since 2001. Cognitive impairment has increased slightly at all ages during the 2000s. Increases in energy levels at all ages during the 2000s are encouraging, reflecting an element of vitality not captured in other symptom or impairment questions.

Past studies have conflicted regarding whether morbidity has been compressed into the period just before death.[48,51–54] Our results are consistent with the findings of compression of morbidity from the late 1980s through the early 2000s,[51–54] and some reversal of this (expansion of morbidity) because of dips in HRQOL in the mid-2000s.[48] However, it is disconcerting that trends in several symptoms and impairments flattened or increased over the 2000s, particularly among the nonelderly. Although these increases did not have large effects in holding back QALE improvement, they did have negative effects, only a portion of which were explained by rising obesity.

The most important question raised by these results is why health has improved so much. In terms of health conditions, advances in cardiovascular disease are known to have made the largest contribution to reduced mortality.[55] Improvements in health behaviors, medical procedures, and pharmaceuticals have dramatically reduced mortality and disability associated with cardiovascular disease,[56] though the magnitude has been debated. In addition to health behaviors and advances in medical care, other factors that can affect health include education and socioeconomic status,[34,57] disease management, environmental change, and changes in the nature of work. Future analyses will help to sort out some of these differing explanations. An important strength of our approach is that it enables detailed tracking of changes in symptoms and impairments among those with different diseases over time,[58] in conjunction with their costs. It also facilitates prediction of the possible impact of different policy interventions. Our approach can be adapted for use in different data sets; it does not require any specific set of symptoms and impairments. There is a high correlation between HRQOL measured by using a smaller versus a larger set of symptoms and impairments. However, our use of the broad set of questions in the Medical Expenditure Panel Survey data enabled us to derive maximal information about the factors underlying health change.

Limitations

This analysis excluded children; additional work is needed to add this population group. Also, we compared QALE only across demographic groups for whom life expectancy has been separately reported over the time period considered, and sample size did not permit disaggregating QALE change separately for each race, gender, and age group.

Although we considered the set of symptoms and impairments and 2 behavioral risk factors consistently tracked by national surveys over time, other factors have an impact on health as well. Also, although we accounted for the changing distribution of obesity and smoking over time, we did not account for factors such as level of physical activity, smoking frequency, or the duration a person has been obese or smoked.[59,60] This could be important because younger cohorts with higher levels of obesity than today's older cohorts may be sicker than middle-aged and older people are today.[61,62] However, offsetting this is improved management of cardiovascular risk factors among all BMI groups.[63] As is typical in QALE estimates, we used a period life table method that necessarily assumes that today's young will change as they age to look like those who are currently middle-aged and elderly, and we extended the same assumption to impairment and symptom profiles over time. Future work could forecast alternate assumptions about the distribution of mortality and morbidity by age group, and examine the effects of other sociodemographic and risk factors.

Although we performed careful adjustments for question differences between surveys and over time (as detailed in the appendix), these may have had some effect on our measurement of change. Finally, the symptoms and impairments we used were self-reported; for impairments that can be physically measured such as sensory and physical abilities, performance is preferred and can be used to adjust self-reported measures.[47]

Conclusions

We found that QALE has increased over the past 2 decades, driven by improvements in life expectancy and reductions in the prevalence of several symptoms and impairments, most notably low energy, depressive mood, pain, self-care, routine needs, and, prior to 2000, anxiety and vision problems. It is encouraging that this health improvement occurred among Blacks and Whites of both genders, despite being moderated by increases in obesity and in the prevalence of some symptoms and impairments. However, continued disparities in health by race and gender, and the more recent increase in some problems, particularly among the nonelderly, are troubling and merit further attention. Harmonizing data from multiple national surveys provides the groundwork for the evaluation of population health outcomes by disease in conjunction with preventive care, medical treatment, and spending over time. Linking symptoms and impairments to diseases over time will provide a deeper understanding of the underlying causes of health change. ■

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Contributors

S. T. Stewart accessed and analyzed study data (most of which were publicly available). All authors were responsible for study concept and design, and interpretation of data analyses. S. T. Stewart drafted the article, with multiple rounds of editing and critical review by D. M. Cutler and A. B. Rosen.

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Human Participant Protection

Institutional review board approval was received for the larger projects of which this was a part; researchers had no interaction with study participants and did not have access to any individually identifiable private information.

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