Two

Health Status-Adjusted Life Expectancy and Health Care Spending for Different Age Groups in the United States

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Abstract
Evaluations of healthcare spending in the United States have considered mortality but not morbidity, thereby potentially inflating estimates of the benefits of spending for older age groups. We estimate health care spending associated with gains in health status-adjusted life expectancy (HALE) for individuals of different ages.

Adjusting for morbidity decreases the value of remaining life expectancy by 5.6 years (8% of unadjusted LE) for those 0-14 years and by 0.9 years (17%) for those 85+ years. Person-level health care expenditures associated with a month of HALE for the youngest age group are $2, versus $224 for those 85 and older.

Our findings suggest that reducing spending on health care for younger populations would impinge on utility in the U.S. population more than would reducing spending on health care for older populations.

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INTRODUCTION

Over the last fifty years, health care spending in the United States has increased from $148 per person per year in 1960, to $1,834 in 1985 and $8,233 in 2010 (OECD, 2012). Over the same period, life expectancy (LE) in the US has increased from 69.8 years in 1960, to 74.7 years in 1985 and 78.7 years in 2010 (OECD, 2012), and conventional wisdom holds that today's medical care is worth its cost.

One recent study compared increases in life expectancy and health care spending from 1960 through 2000 and concluded that the return on spending was favorable (Cutler, Rosen and Vijan, 2006, 927). This analysis, however, was based solely on measures of mortality. Incorporating considerations of morbidity (including disease, disability or other poor health), in addition to mortality, would likely alter estimates of the benefit of health care spending at the population level. For instance, if medical care leads to longer LE but with a measurable burden of morbidity, then the morbidity-adjusted value of LE might be expected to be lower than the unadjusted LE value. Consequently, perceptions of the value of medical care may shift.

Additionally, because younger individuals generally bear a lesser burden of morbidity than older individuals, accounting for morbidity may alter measurements of the relative value of interventions directed toward persons of different ages. Prior studies have provided a mixed picture regarding public valuation of health and health care spending at different ages (Murray and Lopez, 1996; Tsuchiya, 2000; Schmidt, 2003; NICE Citizens Council, 2004; Dolan, Shaw, Tsuchiya and Williams, 2005; Eisenberg et al., 2007), which underscores the need to examine the efficiency of health care spending across the lifespan.

In this study, we use self-rated health status as a measure of morbidity frequently reported for individuals across populations. Using a combination of publicly available data and drawing on literature that provides a framework for translating health status into utility values, we compare unadjusted values of LE with health status-adjusted life expectancy (HALE) values for different age groups within the US population. We then examine health care spending for incremental HALE across age groups and compare those estimates to spending for incremental gains in unadjusted LE.

METHODS

Data Sources

The National Health Interview Survey (NHIS) is a publicly available data source compiled by the National Center for Health Statistics (NCHS). The survey collects a wide range of health-related and demographic data, including self-reported general health status and age. Self-reported general health status is gathered in response to the question, "Would you say your health in general is excellent, very good, good, fair, or poor?" Proxy responses for children are provided by adult caregiver respondents. We used data from the 2008 survey, for which 74,236 people were interviewed (Adams, Heyman and Vickerie, 2008). In order to have robust estimates of health status, we grouped responses in 10-year increments except for the youngest (0-14) and oldest (85 and older) groups.

We drew unadjusted LE data from NCHS Vital Statistics. We used the most recent life tables available (2006), which we consider a valid proxy for 2008 life tables given the typically small differences in LE between proximal calendar years (Arias, 2010). To generate unadjusted LE values for age groups, we calculated population-weighted estimates of LE based on U. S. Census data regarding the size of one-year age cohorts within each age group (U.S. Census Bureau, 2009).

For health care expenditure data specific to age groups, we used the Medical Expenditure Panel Survey (MEPS) as a source of annual health care spending. The MEPS is a nationally representative survey co-sponsored by the Agency for Healthcare Research and Quality (AHRQ) and the NCHS (Kashihara and Carper, 2010). The unweighted sample size for this survey in 2008 was 31,262 respondents (AHRQ, 2009a); of note, the MEPS sample is drawn from among NHIS respondents (AHRQ, 2009b).

All NHIS and MEPS data in the analyses reflect the composition of the civilian, non-institutionalized U.S. population. In 2008, the civilian, non-institutionalized population constituted 99.1% of the total U.S. population (Adams, Heyman and Vickerie, 2008, 2; Kashihara and Carper, 2010; U.S. Census Bureau, 2010).

All analyses were conducted by the authors. The authors had no financial interest in the outcome. The study was exempt from human subjects review as an analysis of de-identified secondary data.

Generation of HALE Values

To convert health status to numeric values, we used data from time trade-off (TTO) analyses in several published studies in which participants were asked how many years in perfect health they would trade for 10 years in their current state of health (Churchill et al., 1987; Tsevat et al., 1991; Van Wijk, Bosch and Hunink, 1998; Bosch and Hunink, 2000; Burstrom, Johanneson and Diderichsen, 2006; Lidgren et al., 2007; Ayalon and King-Kallimanis, 2010 - see Appendix tables for more information.) Based on a review of data from these studies, we obtained utility values for different health states measured in the NHIS. We identified base-case values for converting NHIS health status data to health status utility values and upper- and lower-bound health status utility values to inform sensitivity analyses.

To generate HALE values, we applied health status utility values to the unadjusted weighted mean LE of individuals in each age group, using the weighted mean health status of that age group and the following two equations:

$$\textit{Health status utility}_i = [\Sigma(R_{iE}*U_E)+(R_{iVG}*U_{VG})+(R_{iG}*U_G)+(R_{iF}*U_F)+(R_{iP}*U_P)] / R_i$$

where R=nationally weighted number of respondents, *i*=age group, U=utility value from TTO literature, and *E, VG, G, F* and *P* indicate self-reported health states from the NHIS (excellent, very good, good, fair, poor);

$$\textit{HALE}_i = \textit{Health status utility}_i * \textit{Unadjusted life expectancy}_i$$

For each age group, we compared the unadjusted LE value to the HALE to estimate the degree to which the value of life expectancy is reduced by considering morbidity.

Health Care Spending Per Incremental HALE

We examined health care spending for different age groups by using mean annual expenditure data from the MEPS by age group and HALE values for the same age groups to yield mean expenditures per incremental month of HALE gained for each age group.

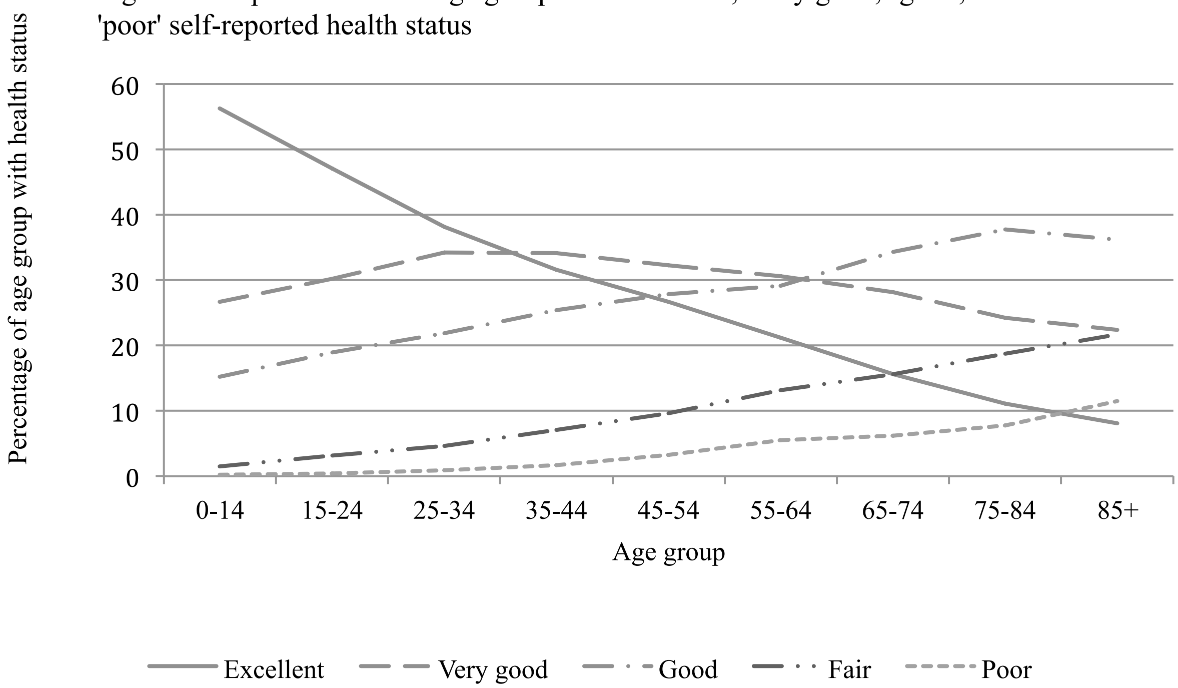
We then compared values of health care spending per incremental month of HALE gained with values of spending per incremental month of unadjusted LE gained.

RESULTS

Health Status, Life Expectancy and HALE

The proportion of people in ‘excellent’ health declines as age increases, and the proportion of people in ‘good,’ ‘fair,’ and ‘poor’ health increases with age (Figure 1). For example, the proportion of people in ‘excellent’ health falls from 56% for people aged 14 years and under, to just 8% for people aged 85 and over. The proportion of people in ‘poor’ or ‘fair’ health combined rises from less than 2% for those aged 0-14 years to 33% for those aged 85 and over.

Figure 1. Proportion of each age group with 'excellent,' 'very good,' 'good,' 'fair' and 'poor' self-reported health status



Source: Authors’ analysis of nationally weighted data from National Health Interview Survey, 2008.

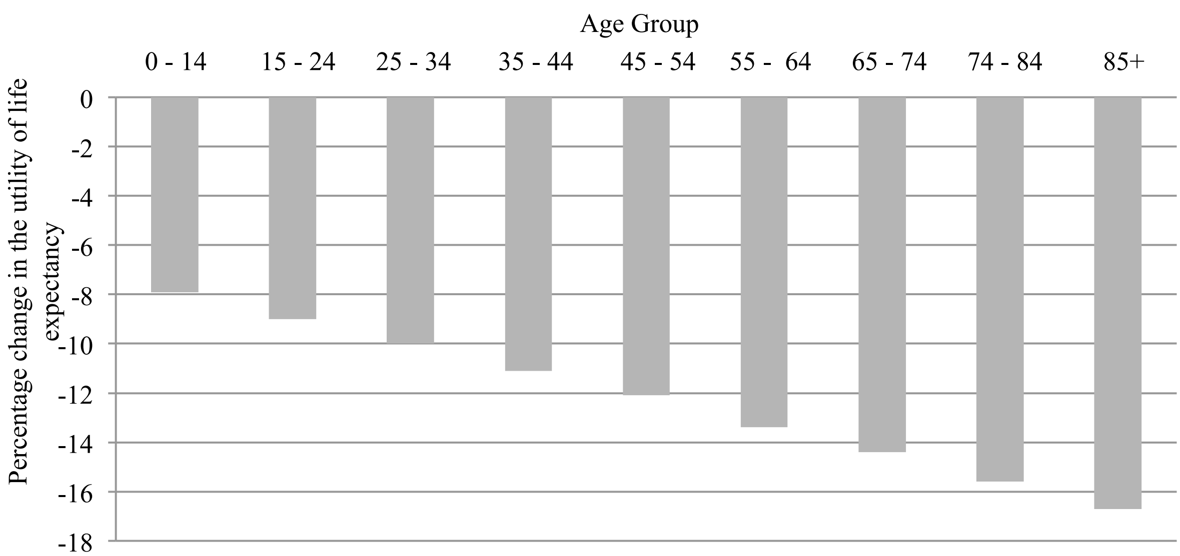
In Figure 2, we compare unadjusted LE with HALE values for each age group, alongside age group-specific health status utility values with which HALEs are generated.

Figure 2. Estimated mean unadjusted life expectancy, health status utility values and HALE values in the non-institutionalized U.S. population in 2008, by age group

Age group (years)	Mean unadjusted life expectancy (years remaining)	*	Health Status utility value	=	Health status-adjusted life expectancy - HALE (years remaining)
0 - 14	71.4		0.921		65.8
15 - 24	59.1		0.910		53.8
25 - 34	49.7		0.900		44.8
35 - 44	40.1		0.889		35.7
45 - 54	31.3		0.879		27.5
55 - 64	23.1		0.866		20.0
65 - 74	15.6		0.856		13.3
75 - 84	9.3		0.844		7.8
85 +	5.0		0.833		4.1

When considering morbidity manifest in self-reported health status, the value of life expectancy was most diminished for the older age groups. For example, children 0-14 lost 7.9% of the value of their life expectancy when adjusted for health status, while people 85 years and older lost 16.7% of the value of their life expectancy (Figure 3).

Figure 3. Percentage change in the utility of life expectancy when adjusted for health status, by age group

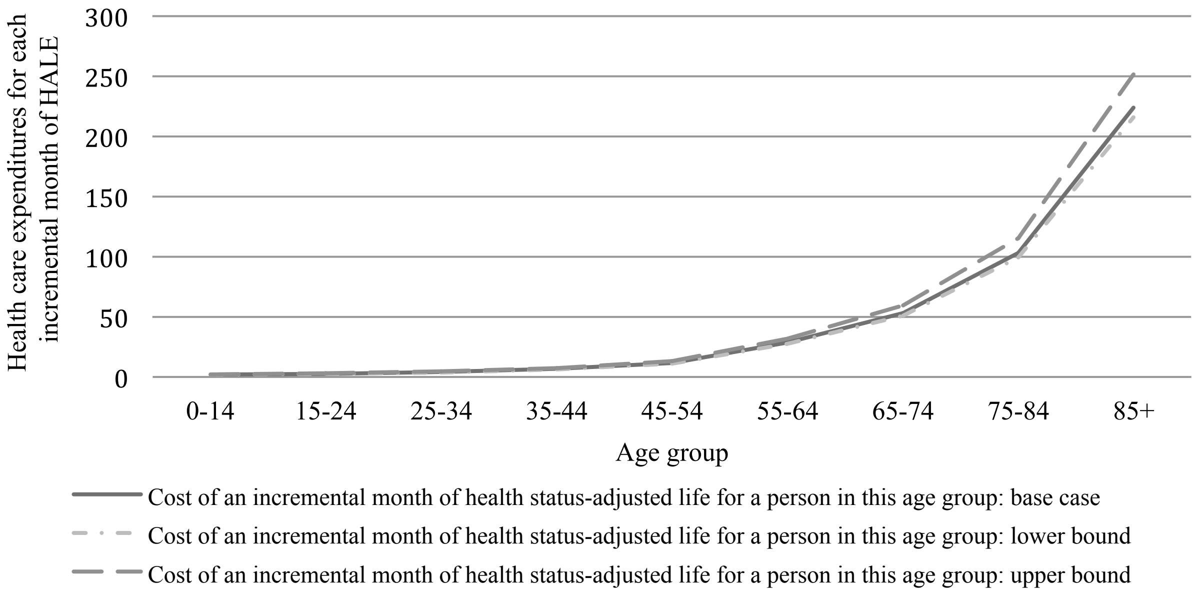


As a sensitivity analysis, we used lower- and upper-bound values of utility corresponding with health status. We found a narrow range of estimated HALE values, in which the pattern of HALEs compared with unadjusted LE was the same as for base-case values (data available from authors upon request).

Health Care Spending and Incremental Months of HALE

We found marked differences across age groups in health care spending associated with each month of HALE (Figure 4). The expenditure associated with a month of HALE for the youngest age group is $2, and under $10 for each age group below 45 years of age. Spending then increases rapidly, so that spending associated with a month of HALE gained for the 75-84 year age group is $103 and for the 85+ group is $224 (all using base-case utility values). In sensitivity analyses, health care spending associated with a month of HALE is quite similar whether lower- or upper-bound utility values are used (Figure 4).

Figure 4. Health Care expenditures per incremental month of HALE, by age group

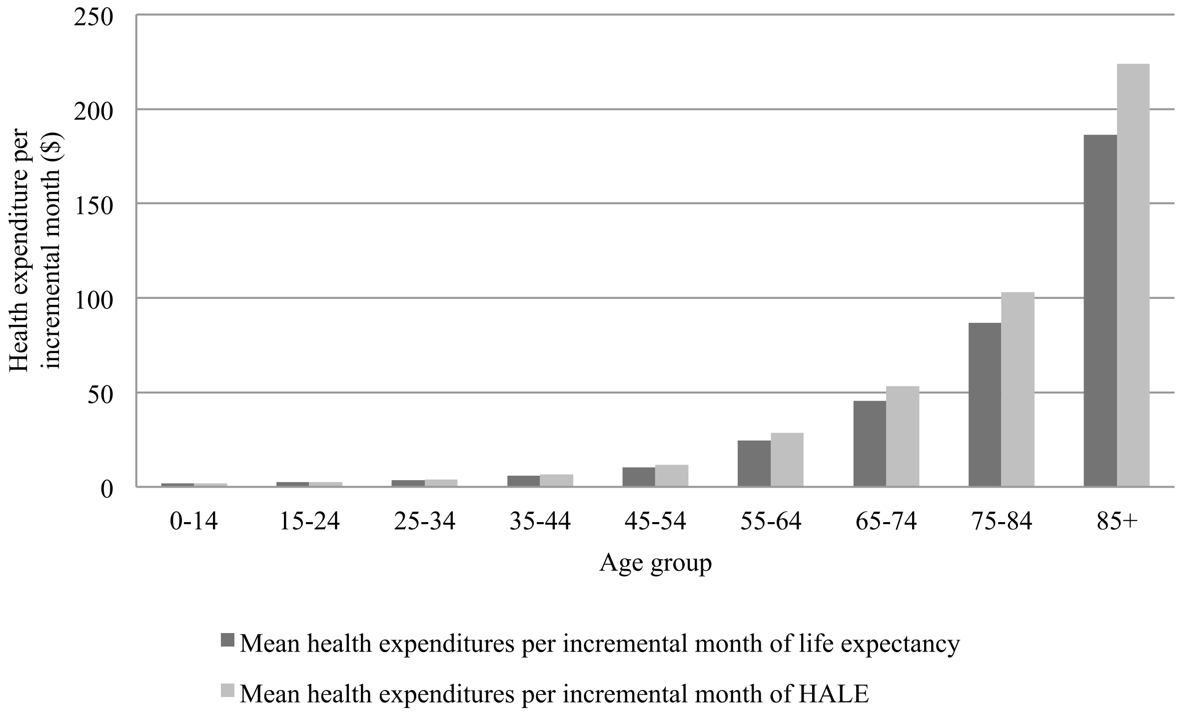


Estimates are presented for base-case assumptions of utility values related to health status, alongside estimates based on lower- and upper-bound assumptions of utility values. Values are in 2008 US$. Sources: Authors' analysis of nationally weighted data from the National Health Interview Survey, 2008, and the Medical Expenditure Panel Survey, 2008.

For younger age groups, expenditures associated with an incremental month of unadjusted LE are similar to expenditures associated with an incremental month of HALE, i.e., whether morbidity is considered little affects the perception of value (Figure 5). For example, an incremental month of life for someone in the youngest age group corresponds to a health care expenditure of $2 whether or not LE is adjusted for health status. In fact, for groups up to 45 years of age an incremental month is associated with less than $10 whether or not life expectancy is adjusted for health status.

In contrast, for older age groups, consideration of morbidity modifies the perception of value of health care spending in substantive ways (Figure 5).

Figure 5. Health care expenditures per incremental month of unadjusted Life Expectancy and HALE, by age group



Values are in 2008 US$. Sources: Authors' analysis of nationally weighted data from the National Health Interview Survey, 2008, and the Medical Expenditure Panel Survey, 2008.

For someone in the 75-84 year age group, an incremental month of HALE costs $103, compared with $87 if considering unadjusted LE. For a person aged 85 or older, an incremental month of HALE is associated with medical costs of $224, compared with $186 if unadjusted LE is used as the denominator.

DISCUSSION

This is the first study to estimate health status-adjusted life expectancy at the national level and examine corresponding age-specific health care spending. We find that worsening health status associated with increasing age means that additional years of life for older people are, on average, perceived as less valuable by the individuals living them compared to years of life perceived by younger people. Compounded with the fact that health care spending is markedly higher for older adults than for young adults and children, we find that health care spending per incremental month of HALE is orders of magnitude higher among seniors than it is among the young. This finding calls into question whether health care spending in the United States has been as uniformly effective as others have suggested (Cutler, Rosen and Vijan, 2006).

While it is widely recognized that per-capita health care spending is higher for older than for younger individuals in the United States, this is the first study to cast these differences in the context of health status-adjusted life expectancy. To the extent that maximizing life expectancy with good quality of life is the goal of medical care, our findings indicate that interventions that extend life will have greater yield when targeted at younger age groups. Of note, our findings are consistent with other research showing that health care spending for younger individuals may be more efficient in extending life expectancy than for the elderly when mortality alone is considered (Cutler, Rosen and Vijan, 2006), although such distinctions have not been emphasized in prior national dialogue about health care expenditures.

The notion that one age group is more appropriately supported or targeted for health care resources than another is supported by some studies and challenged by others (Murray and Lopez, 1996; Tsuchiya, 2000; Schmidt, 2003; NICE Citizens Council, 2004; Dolan, Shaw, Tsuchiya and Williams, 2005; Eisenberg et al., 2007). In the context of our work, interventions for younger populations are most strongly supported by the fact that an incremental month of HALE for individuals in the oldest age group in our study corresponds to health care expenditures amounting to over one hundred times the health expenditures associated with an incremental month of HALE gained by individuals in the youngest age group. In times of extraordinary concerns about rising health care costs in the U.S., it is difficult to justify this stark disparity.

Some readers may be surprised that values of life expectancy were not reduced even more through consideration of health status, with HALEs 8% -17% smaller than unadjusted LE values. This finding is largely attributable to the fact that even people with severe illness in the time trade-off literature were not willing, on average, to trade large amounts of life for better health (Churchill et al., 1987; Tsevat et al., 1991; Van Wijk, Bosch and Hunink, 1998; Bosch and Hunink, 2000; Burstrom, Johanneson and Diderichsen, 2006; Lidgren et al., 2007; Ayalon and King-Kallimanis, 2010). In fact, it was not unusual for several participants in a given study to choose not to give up any life expectancy in exchange for perfect health, which is consistent with research showing that only part of the variation in TTO scores can be explained by responses to descriptive health status questions (Bosch and Hunink, 1996; Ayalon and King-Kallimanis, 2010). While surprising, given the severe impact poor health might be expected to have on one's enjoyment of life, this finding is consistent with people valuing their remaining life-years based on a range of attributes, of which health status is only one.

Limitations

Our findings and interpretations must be viewed in light of certain limitations of these analyses. Using a different utility measure would likely have yielded different results. Studies in which participants provided both TTO scores and other utility scores show that TTO scores are generally higher than other utility values for the same health condition (Tsevat et al., 1991; Bosch and Hunink, 2000; Burstrom, Johanneson and Diderichsen, 2006). Despite these known differences in measures of utility with distinct measurement tools, we note that using other utility measures would have led to greater reductions in the value of life expectancy when adjusted for health status than what we found with TTO-based values. Therefore, our findings are conservative, and using a different utility measure would produce more pronounced differences between unadjusted LE and HALE than those presented here.

Another factor that likely makes our estimates more conservative is our use of data from the NHIS and MEPS. Both sets of data are sampled and weighted to be representative of the civilian, non-institutionalized population in the US, which may bias our estimates. For instance, one may expect health status to be worse and health care expenditures to be higher for the members of the institutionalized population (including those in long term care facilities such hospitals for the chronically ill or mentally disabled, nursing homes, and prisons) than for the non-institutionalized population. Therefore, our estimates of health care spending per incremental gain in HALE are likely lower than one would generate from an even broader, full-population study of HALE—data sources for which do not currently exist at the national level. Although the National Health Expenditure Accounts, used by other authors in similar analyses (Cutler, Rosen and Vijan, 2006) include health care spending for institutionalized persons in the U.S., they are not available for the defined age groups that we used to provide detailed patterns across the age spectrum in our analysis.

We are not aware of any studies that translate self-reported health status directly into utility values, so we used TTO studies to anchor the top and bottom of our health status adjustment value scale, and divided the range into equal steps. Thus, we assume the difference between ‘fair’ and ‘good’ health is equal to the difference between ‘good’ and ‘very good’ health, and so on, and that such increments are stable across age groups. While we have no evidence that these assumptions are correct, we are not aware of evidence to the contrary.

This study was based on the self-reported health status measure of the NHIS. We chose this measure because it is available in a robust, nationally representative survey that indicates the overall health status of the population. There is good evidence to indicate that this measure is valid, such as the strong relationship between self-reported health status and mortality in the next year (De Salvo et al., 2005). However it is also possible that self-reported health status can vary in ways that do not reflect changes in utility.

Finally, our study assumes that all the benefits from health care spending on an individual accrue to the age group in which the spending occurs. It is possible that some of the benefits of expenditures may accrue to patients later in life, and not necessarily entirely in the time frame in which the expenditure was made. The exception is for spending in the 85+ age group, which — with the highest health care expenditures and smallest incremental HALE gain — is arguably the most important group for whom this limitation is mitigated.

CONCLUSION

Estimates of the yield of health care spending per unit of life expectancy are lower when considering morbidity and mortality than when considering mortality alone. Moreover, when adjusting the value of life-years for health status, spending per incremental year of HALE is higher for adults than for children, and markedly higher for older adults than younger adults.

In an age of real and threatened cuts to public programs, our findings suggest that reducing spending on health care for younger populations would impinge on utility in the U.S. population more than reducing spending on health care for older populations. At the margin, a dollar of health care spent on the relatively young generates more utility than a dollar spent on the relatively old. In terms of possible budget solutions proposed, our analysis suggests that constraining Medicare eligibility or benefits — whether or not a sound decision from other points of view — would be more appropriate than limiting the Medicaid expansion envisioned in the Affordable Care Act.

SUPPLEMENTAL APPENDIX A – Time Trade-Off and Health Status

Time Trade-Off (TTO) values used in this analysis are based on published research studies, all of which are referenced in the main manuscript. A value of 1 means a participant would trade no years of life for better health. A score of 0.5 means a participant would trade ten years in their current health state for five years in perfect health.

Appendix table A1. Time Trade-Off values

Sample	*TTO scores*	*Notes*
2549, 20-88 year-olds in the general Swedish population. (Burstrom, Johanneson and Diderichsen, 2006)	Mean: 0.919 Range: 0.699 (average for people aged 80-88) to 0.961 (average for people who have no health issues based on the EuroQol EQ-5D).	71% of respondents had a TTO score of 1: i.e. they traded off no life expectancy for perfect health.
952 Americans over the age of 50. Mean age= 68, 40% had medical conditions, 13% had depressive symptoms. (Ayalon and King-Kallimanis, 2010)	Mean: 0.686	121 people gave a TTO of <0.1 and 275 gave a score of 1.
345 Swedish breast cancer patients. (Lidgren et al., 2007)	Range: 0.82 (average for patients with metastatic disease) to 0.901 (average for patients in first year after primary breast cancer diagnosis).	A majority of patients in first year after primary breast cancer had a TTO value of 1.
272 patients with end-stage renal disease. (Churchill et al., 1987)	Range: 0.43 (for hospital hemo dialysis patients) to 0.84 (for transplant patients).	
88 Dutch patients with intermittent claudication, before and after treatment. (Bosch and Hunink, 2000)	Range: 0.82 (before treatment) to 0.89 (three months after treatment).	
80 American heart attack survivors. (Tsevat et al., 1991)	Mean: 0.87	Range for a subsample of ten patients was 0.75 to 1.0
65 peripheral arterial occlusive disease patients. (Van Wicjk, Bosch and Hunink, 1998)	Mean: 0.85	

Source: (Churchill et al., 1987; Tsevat et al., 1991; Van Wicjk, Bosch and Hunink, 1998; Bosch and Hunink, 2000; Burstrom, Johanneson and Diderichsen, 2006; Lidgren et al., 2007; Ayalon and King-Kallimanis, 2010).

Appendix table A2. Health status utility values used to convert life expectancy to HALE.

NHIS health status	Base case health status utility values	Upper bound health status utility values	Lower bound health status utility values
Excellent	0.961	1.000	0.840
Very Good	0.896	0.935	0.815
Good	0.830	0.869	0.749
Fair	0.765	0.804	0.684
Poor	0.699	0.738	0.618

Source: Authors' analysis of Time Trade-Off literature, as referenced in Appendix table A.1.

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