Differences in healthy life expectancy for the US population by sex, race/ethnicity and geographic region: 2008

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ABSTRACT

Background Healthy life expectancy (HLE) varies among demographic segments of the US population and by geography. To quantify that variation, we estimated the national and regional HLE for the US population by sex, race/ethnicity and geographic region in 2008.

Methods National HLEs were calculated using the published 2008 life table and the self-reported health status data from the National Health Interview Survey (NHIS). Regional HLEs were calculated using the combined 2007–09 mortality, population and NHIS health status data.

Results In 2008, HLE in the USA varied significantly by sex, race/ethnicity and geographical regions. At 25 years of age, HLE for females was 47.3 years and ~2.9 years greater than that for males at 44.4 years. HLE for non-Hispanic white adults was 2.6 years greater than that for Hispanic adults and 7.8 years greater than that for non-Hispanic black adults. By region, the Northeast had the longest HLE and the South had the shortest.

Conclusions The HLE estimates in this report can be used to monitor trends in the health of populations, compare estimates across populations and identify health inequalities that require attention.

Keywords ethnicity, life expectancy, morbidity, mortality, race, region, sex

Introduction

Healthy life expectancy (HLE) is a population health measure that combines age-specific mortality with morbidity or health status data to estimate expected years of life in good or better health for people at a given age.[1] Public health officials, health-care providers and policymakers have used HLE to understand the overall health status of a population and to identify health inequalities in population subgroups.[2–4] HLE has also been used in several *Healthy People* reports to monitor progress in health promotion, eliminating disparities and improving quality of life for the US population.[5]

HLE calculations begin with estimates of life expectancy (LE). LE or expected years of life at a given age in a given year is the average remaining years of life a person can expect to live, assuming that the observed mortality rates for the population in that year continue into the foreseeable future.[6,7]

HLE at the same age reveals the years of LE that are expected to be lived in good or better health.

Annual death rates have declined and corresponding estimates of LE have increased during the past century in the USA.[5] Between 1900 and 2000, an average LE increased by 62.8%, from 47.3 to 77.0 years.[8] The substantial gain in LE at birth and above 64 years produced a dramatic change in the age structure of the population. The percent of the US population

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aged 65 years and older increased 3-fold from 4.1 to 12.4% during 1900–2000.[9] Mortality rates vary by demographic, behavioral, clinical, social and environmental factors.[3] Disparities in mortality become apparent when LE is evaluated by these determinants.[3,10] Traditionally, LE has been used as a health measure to describe the longevity of a population. But as populations age, health assessments that include both length and quality of life are needed in public health practice. Using both LE and HLE, health planners can determine whether populations are living longer lives in better health.

In this study, we estimated national HLE for the US population by sex and race/ethnicity using the available official 2008 US life tables published by the National Center for Health Statistics (NCHS)[11] and the self-reported health status data from the National Health Interview Survey (NHIS). For regional LE and HLE, we used abridged life tables and combined the 2007–09 health data with mortality data and census data to increase the reliability of the estimates.

Methods

Sources of data

Census population estimates
The US Census Bureau midyear population estimates for 2007–09 were used to calculate age-, sex- and race-/ethnicity-specific mortality rates for the regional LE estimates. To calculate regional LE and HLE estimates, we used the bridged-race[11–14] intercensal estimates from 1 July 2007 to 2009 stratified by year, age group (<1, 1–4, 5–84 in 5-year intervals and 85+), bridged race/ethnicity and sex.

Mortality data
The 2007–09 mortality data were reported by states and compiled by the NCHS in categories of single race or multiple race. To calculate regional death rates, the multiple-race mortality data were bridged to the single-race categories based on the standards issued by the Office of Management and Budget (OMB) in 1977.[14,15]

National Health Interview Survey
NHIS health status data were derived from the survey question: 'Would you say your health in general is excellent, very good, good, fair, or poor?' (Supplementary data, Appendix SI).[16] A response of 'fair' or 'poor' was classified as unhealthy; and 'excellent', 'very good' or 'good' was classified as healthy; and 'refused', 'not ascertained' or 'don't know' (0.18% in the 2008 NHIS data) was excluded from the analysis. The 2008 self-reported health status data were used to calculate HLEs at the national level, and the 2007–09 health data were combined to obtain stable HLE estimates at the regional level.

Statistical analysis
We calculated HLE using methods developed by Sullivan.[17] We used the 2008 age-specific LE estimates from the life table published by the NCHS to calculate the national HLE estimates.[11] For the regional LE, we first calculated 2007–09 age-specific death rates by adjusting the death counts for unknown age and misclassification of Hispanic origin on death certificates.[11,18] We used an abridged life table method to calculate the regional LE for age groups in 5-year intervals.[19] We used the proportion of missing age in the total population to adjust for the small number of deaths with missing age on death certificates.[11] We assumed the NCHS classification ratios at the national level were consistent with those at the regional level and adjusted the national and regional race-/ethnicity-specific mortality.[11,18–21] Detailed methods on adjustment for misclassificaiton of Hispanic origin is available in Supplementary data, Appendix SII. HLE estimates were calculated from the LE estimates using the NHIS 2008 (at the national level) or 2007–09 (at the regional level) self-reported health status data. The Supplementary data, Appendix SIII describes the methods used to calculate HLE. The detailed methods for calculating HLE have been published by Molla and colleagues.[8] The HLE plausibility ranges were calculated from the lower and upper limits of 95% confidence bounds for age-specific death rates and self-reported health status data.[22] The values listed for any ethnic group are the minimum and maximum values that resulted from the use of upper and lower confidence bounds for the data sources.

We present national and regional (Northeast, Midwest, South and West) estimates for the following: (i) LE (national LE estimates adopted from NCHS), (ii) HLE and (iii) HLE as a percent (%) of LE by age, sex (male and female) and racial/ethnicity (Hispanic, non-Hispanic white and non-Hispanic black). We present the LE and HLE estimates at ages 25 and 65 years to illustrate differences found in young adult populations versus those found in older adult populations. Disparities in HLE were assessed by calculating the absolute difference in HLE between two population subgroups, and significance was determined using the two-tailed Z statistic with $P < 0.05$.

NHIS used a complex sample design involving stratification, clustering and multistage sampling. Health status prevalence estimates were calculated using the statistical software SAS 9.3 (SAS Institute, Cary, NC) and SAS-Callable SUDAAN 10.0 (Research Triangle Institute, Research Triangle Park, NC).

Results

All-cause mortality rates and the demographic characteristic of the US population by health status and region of residence are presented in Supplementary data, Tables S1–S3. National

LE and HLE estimates by sex and race/ethnicity for all age groups in the USA are presented in Table 1. Figure 1 shows HLE across the life span by sex and race/ethnicity. HLE was 45.9 years for the US population for both sexes and all races at age 25 and 14.0 years at age 65 (Table 1). At age 25, HLE differed significantly by sex and race/ethnicity ($P < 0.001$). HLE for adults aged 25 was 45.9 years; females had ∼2.9 years more HLE than males (47.3 and 44.4 years, respectively). HLE as a percent of LE was 85.4% for males and 83.8% for females. At age 25, HLE for non-Hispanic white adults was 2.6 years greater than that for Hispanic adults and 7.8 years greater than that for non-Hispanic black adults (46.8, 44.2 and 39.0 years). At age 65, the differences in HLE between demographic groups were less than those found at age 25 (Table 1, Figs 1 and 2). The difference in HLE between males and females gradually declined with age, from 2.9 years at age 25 to 1.9 years by age 65. The difference in HLE between Hispanics and non-Hispanic whites dropped from 2.6 years at age 25 to 1.5 years at age 65 and dropped from 7.8 years at age 25 to 3.9 years at age 65 between non-Hispanic whites and non-Hispanic blacks. At age 65, HLE as a percent of LE was 74.8% for males, 74.4% for females, 62.8% for Hispanics, 77.0% for non-Hispanic whites and 61.3% for non-Hispanic blacks. HLEs at age 25 by sex, race/ethnicity and region are shown in Fig. 2 and in Supplementary data, Table S4. HLE at age 25 was ∼3 years greater for females than that for males in all four regions with the highest in the Northeast and the lowest in the South. HLE for non-Hispanic whites was greater than that for Hispanics in all four regions and the difference ranged from 5.6 years in the Northeast to 0.9 years in the South (Figs 3 and 4). At age 65, a similar pattern was seen: in general, the South had the lowest HLE compared with the other regions among all demographic subgroups (Supplementary data, Table S4).

Discussion

Main findings of the study

HLE varied significantly by sex, race/ethnicity and region in the USA in 2008. On average in the USA, LE and HLE for females are higher than that for males in all age groups. At the regional level, differences in HLE by sex and race/ethnicity existed in all four regions. In general, the South had lower HLE estimates than the other three regions for both sexes, and the Hispanic, non-Hispanic white and black populations. In each region, the differences by sex and race/ethnicity were larger at the younger ages than at the older ages. The Midwest had the largest sex difference in HLE and the West had the smallest at both 25 and 65 years of age. In general, the South

had the smallest difference in HLE between any racial/ethnic groups than the other three regions.

What is already known on this topic

Available reports on HLE estimates for the US population and its demographic subgroups are limited in scope and geographic detail. Molla and colleagues have described the methods and analytic issues related to the calculation of HLE.[8,23] A recent report published by the Centers for Disease Control and Prevention (CDC) provided state-specific HLE estimates and measured disparities by sex and race for the US population aged 65 years.[24] They reported that females had a greater HLE than males at age 65 in every state and DC, and HLE was greater for whites than that for blacks in all states and DC from which sufficient data were available except in Nevada and New Mexico. Pamuk and colleagues conducted a study to assess the impact on LE and HLE of attaining the specific Healthy People 2010 objectives, and HLE would increase by 5.8 years if Healthy People 2010 mortality and assumed morbidity targets were attained.[3] The US Department of Health and Human Services (USDHHS), Office of the Assistant Secretary for Planning and Evaluation (ASPE) provides annual estimates of HLE with and without activity limitations for the US population and selected demographic groups.[25] Solomon and colleagues assessed country-specific HLE for 187 countries using data from the Global Burden of Disease (GBD) project. They reported substantial differences in HLE among countries in 2010.[4]

What this study adds

The HLE estimates in this report can be used to monitor trends in the health of the US population, compare estimates across segments of the population and identify health inequalities that require national attention. In this study, we chose HLE, because its method is simpler to understand and its data requirements less extensive than for alternative summary health measures.[26,27] Thus, HLE is potentially more useful for smaller demographic groups and geographic areas. In this report, we focus on HLE at age 25 and 65 to illustrate the sex and racial/ethnic differences that change with age. HLE for younger adults might be an indication of the impact of safe and healthy living environments, health behaviors and preventive services in childhood, whereas HLE in older adults might represent the accumulation of health determinants through adulthood. Differences in risk factors that cause morbidity and mortality may be underlying causes for the disparities that are seen in HLE. HLE measures are not disease specific and do not identify the reasons for poor health or shorter lives,[1] but they provide an overview of population

Table 1 LE and HLE[a] by sex and race/ethnicity for the US population, 2008

Age (years)	All races				Sex							
	Both sexes				Male				Female			
	LE[b]	HLE	HLE plausibility range[c]	% (HLE/LE)	LE	HLE[d]	HLE plausibility range	% (HLE/LE)	LE	HLE[d]	HLE plausibility range	% (HLE/LE)
<1	78.1	69.3	(68.4–70.3)	88.7	75.6	67.6	(66.8–69.2)	89.4	80.6	70.9	(69.8–72.6)	88.0
1–4	77.6	68.7	(67.9–69.8)	88.5	75.1	67.1	(66.1–68.5)	89.3	80.1	70.3	(69.1–71.8)	87.9
5–9	73.7	64.9	(64.1–66)	88.0	71.2	63.2	(62.2–64.6)	88.7	76.1	66.5	(65.2–67.9)	87.3
10–14	68.8	60.0	(59.2–61.1)	87.2	66.3	58.4	(57.4–59.7)	88.0	71.2	61.6	(60.4–63.0)	86.5
15–19	63.8	55.1	(54.4–56.2)	86.4	61.3	53.5	(52.6–54.8)	87.2	66.2	56.7	(55.5–58.1)	85.6
20–24	59.0	50.4	(49.7–51.5)	85.5	56.6	48.8	(47.9–50.1)	86.3	61.3	52.0	(50.8–53.3)	84.7
25–29	54.3	45.9	(45.2–46.9)	84.5	52.0	44.4	(43.5–45.6)	85.4	56.5	47.3	(46.2–48.6)	83.8
30–34	49.5	41.4	(40.7–42.3)	83.5	47.3	39.9	(39.1–41.1)	84.4	51.6	42.7	(41.7–44.0)	82.8
35–39	44.8	36.8	(36.2–37.8)	82.3	42.6	35.4	(34.7–36.6)	83.1	46.8	38.2	(37.2–39.4)	81.6
40–44	40.1	32.5	(31.9–33.4)	81.0	38.0	31.0	(30.3–32.2)	81.7	42	33.8	(32.9–34.9)	80.4
45–49	35.5	28.3	(27.8–29.2)	79.7	33.5	26.9	(26.3–28.0)	80.4	37.3	29.6	(28.7–30.7)	79.2
50–54	31.0	24.3	(23.8–25.1)	78.2	29.1	22.9	(22.4–24.0)	78.7	32.8	25.5	(24.8–26.6)	77.8
55–59	26.8	20.6	(20.2–21.4)	76.9	25.0	19.3	(18.8–20.3)	77.2	28.4	21.8	(21.1–22.7)	76.7
60–64	22.7	17.2	(16.8–17.9)	75.7	21.0	16.0	(15.5–16.9)	76.0	24.1	18.2	(17.6–19.1)	75.5
65–69	18.8	14.0	(13.7–14.7)	74.6	17.3	13.0	(12.6–13.8)	74.8	20	14.9	(14.3–15.7)	74.4
70–74	15.2	11.1	(10.8–11.7)	73.1	13.9	10.2	(9.9–11.0)	73.7	16.2	11.7	(11.3–12.5)	72.7
75–79	11.8	8.4	(8.2–9)	71.2	10.7	7.7	(7.5–8.4)	71.9	12.6	8.9	(8.6–9.6)	70.7
80–84	8.9	6.1	(6.0–6.7)	69.0	8.0	5.5	(5.3–6.1)	68.1	9.5	6.6	(6.4–7.2)	69.5
85+	6.4	4.3	(4.3–4.8)	66.8	5.7	3.7	(3.6–4.3)	64.5	6.8	4.6	(4.5–5.1)	67.9

Continued

Table 1 Continued

Age (years)	All races				Sex							
	Both sexes				Male				Female			
	LE^b	HLE	HLE plausibility range^c	% (HLE/LE)	LE	HLE^d	HLE plausibility range	% (HLE/LE)	LE	HLE^d	HLE plausibility range	% (HLE/LE)
	Race/Ethnicity											
	Hispanic				Non-Hispanic white				Non-Hispanic black			
	LE	HLE^d	HLE plausibility range	% (HLE/LE)	LE	HLE^d	HLE plausibility range	% (HLE/LE)	LE	HLE^d	HLE plausibility range	% (HLE/LE)
<1	81.0	67.6	(65–71.1)	83.5	78.4	70.5	(69.5–71.8)	89.9	73.7	61.4	(59.5–64.8)	83.4
1–4	80.4	67.0	(64.1–70.2)	83.3	77.8	69.9	(68.8–71.1)	89.8	73.6	61.2	(58.6–64.0)	83.2
5–9	76.5	63.1	(60.3–66.3)	82.5	73.9	66.0	(64.9–67.2)	89.3	69.8	57.5	(54.9–60.1)	82.4
10–14	71.5	58.3	(55.4–61.4)	81.4	68.9	61.1	(60.0–62.2)	88.6	64.8	52.7	(50.3–55.3)	81.3
15–19	66.6	53.4	(50.6–56.5)	80.2	64.0	56.2	(55.2–57.3)	87.8	59.9	48.0	(45.6–50.5)	80.1
20–24	61.8	48.7	(46–51.8)	78.9	59.1	51.5	(50.5–52.6)	87.0	55.1	43.4	(41.1–45.9)	78.7
25–29	57.0	44.2	(41.5–47.2)	77.6	54.4	46.8	(45.9–47.9)	86.1	50.5	39.0	(36.9–41.4)	77.3
30–34	52.2	39.7	(37.1–42.6)	76.0	49.6	42.3	(41.5–43.3)	85.3	45.9	34.7	(32.7–37.0)	75.7
35–39	47.4	35.1	(32.6–38.0)	74.1	44.9	37.8	(37.0–38.8)	84.2	41.3	30.3	(28.4–32.6)	73.4
40–44	42.7	30.8	(28.3–33.5)	72.1	40.2	33.4	(32.6–34.3)	83.1	36.7	26.1	(24.3–28.3)	71.0
45–49	38.0	26.6	(24.3–29.3)	70.1	35.6	29.2	(28.5–30.1)	82.0	32.3	22.2	(20.5–24.3)	68.5
50–54	33.4	22.6	(20.5–25.2)	67.7	31.1	25.1	(24.5–26.0)	80.6	28.1	18.6	(17.1–20.6)	66.2
55–59	29.0	19.0	(17.0–21.4)	65.4	26.8	21.3	(20.8–22.1)	79.5	24.3	15.5	(14.0–17.3)	63.8
60–64	24.8	15.9	(14.0–18.1)	64.0	22.7	17.8	(17.3–18.5)	78.3	20.7	12.7	(11.4–14.5)	61.6
65–69	20.7	13.0	(11.4–15.1)	62.8	18.8	14.5	(14.0–15.2)	77.0	17.3	10.6	(9.4–12.1)	61.3
70–74	16.9	10.3	(8.8–12.2)	60.9	15.1	11.4	(11.1–12.1)	75.7	14.2	8.3	(7.2–9.7)	58.7
75–79	13.4	8.0	(6.8–9.9)	60.1	11.8	8.7	(8.4–9.2)	73.5	11.3	6.4	(5.5–7.6)	56.7
80–84	10.2	5.8	(4.8–7.5)	57.0	8.8	6.3	(6.1–6.8)	71.2	8.8	4.8	(4.1–5.9)	55.2
85+	7.4	4.2	(3.6–5.9)	56.5	6.4	4.3	(4.2–4.8)	68.0	6.6	4.0	(3.4–4.9)	60.8

SOURCES: CDC/NCHS, National Vital Statistics System, National Health Interview Survey and the US Census Bureau.

[a]Methodologies used for calculating HLE can be found in the Supplementary, Appendix SIII.

[b]Adapted from the US Life Tables, 2008, published in the National Vital Statistics Reports by NCHS.[11]

[c]HLE plausibility ranges were calculated from the lower and upper 95% confidence bounds for age-specific death rates and self-reported health status data.[22]

[d]Significance between two populations was tested assuming no sample variance for mortality rates. All pairwise comparisons for HLE between males and females, Hispanics and non-Hispanic whites, and Hispanics and non-Hispanic blacks were significantly different for all age groups at P-value <0.05 based on two-tailed z-statistics, except between Hispanics and non-Hispanic whites at age 80–85+, and Hispanics and non-Hispanic blacks at age 85+.
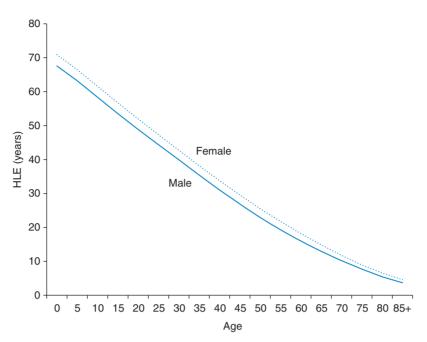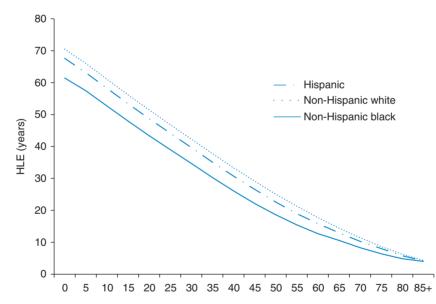
Fig. 1 HLE by sex and age, USA, 2008.

Fig. 2 HLE by race/ethnicity and age, USA, 2008.

health that might be easily understood by policy makers, health-care providers and the general public.

The sex differences in HLE confirmed in this report have been observed in other studies.[1,28–30] A study assessing sex differences in HLE for 23 countries showed larger HLE for females than for males in 15 out of 23 countries.[31,32] HLE for the non-Hispanic whites was higher than that for the Hispanics, but LE for the Hispanics was higher than that for the non-Hispanic whites. Prior US studies have also reported that Hispanics have a higher LE than non-Hispanic whites

and non-Hispanic blacks.[11,33] These findings suggest that Hispanics might have a mortality advantage (longer LE), but a greater proportion of their lives are 'unhealthy'. Several explanations have been proposed to explain the Hispanic adult mortality advantage such as cultural and lifestyle behaviors, data artifact and return migration of ill migrants.[20,21,33,34] Prior research found that 5% of total Hispanic deaths, 1% of total non-Hispanic black deaths and less than one-half of a percent of non-Hispanic white deaths were under-reported on death certificates.[20,21] Lower HLE in
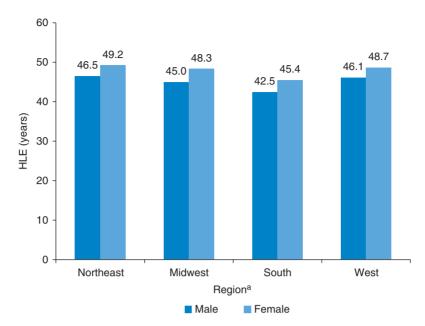
Fig. 3 HLE at age 25 by sex and region, USA, 2007–09. [a]Significant at P-value <0.05 between males and females in all four regions.
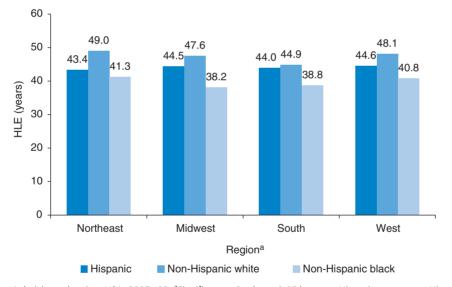

Fig. 4 HLE at age 25 by race/ethnicity and region, USA, 2007–09. [a]Significant at P-value <0.05 between Hispanics versus non-Hispanic whites and Hispanics versus non-Hispanic blacks in all four regions.

the South than in other regions may be the result of lower prevalence of good or better health status compared with the other three regions (Supplementary data, Tables S1–S3). Residents of the Southern region consistently have reported the least favorable rates of poverty, adult smoking, physical inactivity and death rates compared with residents of the other three regions.[35] Examining HLE by additional demographic and socioeconomic factors might reveal additional reasons for differences by region of the country. One study has reported that HLE increased with levels of education

regardless of sex or race.[36] Another study found that US adults in 2008 with <12 years of education had a LE not much better than that for adults in the 1950s and 1960s.[37] Because differences in HLE might result from variations in morbidity, mortality or both indicators, examining HLE as a percent of LE reveals populations that might be enduring illness or disability for more years of life.

We urge caution in interpreting and comparing HLE estimates across studies for different populations, particularly when comparing studies from different countries. Differences

in study design and execution across studies that might impact the HLE estimates include completeness and quality of the mortality and census data for specific demographic groups.[1,8] The criteria used to define health status or morbidity states may substantially influence HLE estimates (examples are presented in the Supplementary data, Appendix SI). The morbidity component for HLE can be assessed in different ways, but the use of a self-reported health status measure that is routinely collected in a standard fashion at varying geographic levels with extensive demographic data enables the type of analyses in this report. Self-rated general health status questions, as used in the National Health Interview Survey, have been shown to be good predictors of health outcome measures.[38,39]

Compared with other measures of morbidity such as disability or health-related quality of life,[8] self-rated general health status questions are easy to interpret and relatively less expensive and burdensome to collect.[40,41] However, because self-assessed health status is influenced by age, sex, ethnicity and other factors, the health rankings (excellent, very good, good, fair and poor) may be assessed inconsistently across demographic groups.

Although there is no conclusive evidence on differences in self-assessed health by these factors,[38] it is likely that certain populations may rank their health status lower or higher compared with others. One study found that Spanish-speaking respondents among US Hispanics were more likely to report fair or poor health (39%) than English-speaking participants (17%) and concluded that this finding reflects cultural or linguistic influences on self-assessed health status.[42] In the 2007−09 NHIS survey, 5.0% of the interviews were conducted in Spanish, and 2.8% was conducted using both English and Spanish.[43−45] If the Hispanic respondents to the NHIS were more likely to report fair or poor health due to cultural or linguistic factors, the HLE estimates for this population would have been lower than expected if there were no bias.

Limitations of this study

The study includes the following limitations. First, we attempted to adjust for misclassification of Hispanic ethnicity on death certificates, yet residual misclassification may have remained and would have magnified or diminished the differences in HLE in unpredictable ways. Studies have shown that agreement on race and ethnicity between census self-report and death certificate was highly consistent for whites and blacks but less so for the Hispanic population.[18,20] In this study, we adjusted death rates for missing age and for ethnic misclassification on death certificates.[11,18] However, we were only able to adjust misclassification for the regional estimates

using the national classification ratios estimated by NCHS. The accuracy and reliability of the estimates by Hispanic origin are functions of the applicability of the adjustment factors at the regional level. Additional data sources and specific studies would be needed to validate the difference of these classification ratios for the national and regional level. Studies have found that the institutionalized population had higher disease burden[46] and mortality[47] than the general population. The NHIS health status estimates excluded persons living in military households and institutions (i.e. prisons, nursing homes, etc.), but their deaths were included in the analysis of LE. This may have resulted in underestimation of the prevalence of being unhealthy and related HLE in the general population and its demographic segments. Adjustment for the underestimate of HLE in this study was impractical using the available mortality data. Lastly, incomplete adjustment for non-response bias in the NHIS was possible. The NHIS response rate for adult sample person component from 2007 to 2009 at the national and regional level ranged from 62.6 to 67.8%.[48−50]

Conclusions

In this report, differences in HLE were observed among population segments and different geographic areas in the USA. This information can be used as a baseline to study the combined effects of morbidity and mortality on the future health in specific populations. Understanding population-specific determinants of HLE can lead to better targeting of resources to eliminate disparities and improve population health.

Supplementary data

Supplementary data are available at *PUBMED* online.

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