The burden of health conditions across race and ethnicity for aging Americans
Disability-adjusted life years
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Abstract
Despite evidence suggesting race and ethnicity are important factors in responses to environmental exposures, drug therapies, and disease risk, few studies focus on the health needs of racially- and ethnically-diverse aging adults.

The objective of this study was to determine the burden of 10 health conditions across race and ethnicity for a nationally-representative sample of aging Americans.

Data from the 1998 to 2014 waves of the Health and Retirement Study, an ongoing longitudinal-panel study, were analyzed. Those aged over 50 years who identified as Black, Hispanic, or White were included. There were 5510 Blacks, 3423 Hispanics, and 21,168 Whites in the study.

At each wave, participants reported if they had cancer, chronic obstructive pulmonary disease, congestive heart failure, diabetes, back pain, hypertension, a fractured hip, myocardial infarction, rheumatism or arthritis, and a stroke. Disability-adjusted life years (DALYs) were calculated for each health condition by race and ethnicity. Ranked DALYs determined how race and ethnicity was differentially impacted by the burden of each health condition. Sample weights were utilized to make DALY estimates nationally-representative.

Weighted DALY estimates (in thousands) ranged from 1405 to 55,631 for Blacks, 931 to 28,442 for Hispanics, and 15,313 to 295,623 for Whites. Although the health conditions affected each race and ethnicity differently, hypertension had the largest number of DALYs, and hip fractures had the fewest across race and ethnicity. In total, there were an estimated 198,621, 101,462, and 1,187,725 DALYs for older Black, Hispanic, and White aging adults.

Our findings indicate that race and ethnicity may be influential on health and disease for aging adults in the United States. Monitoring DALYs may help guide the flow of health-related expenditures, improve the impact of health interventions, advance inclusive health care for diverse aging adult populations, and prepare healthcare providers for serving the health needs of aging adults.

Abbreviations: COPD = chronic obstructive pulmonary disease, DALY = disability-adjusted life year, HRS = health and retirement study, YLD = years lost due to disease/disability, YLL = years of life lost.

Keywords: aging, DALY, epidemiology, geriatrics, mortality

1. Introduction
Federal mandates of biomedical research in the United States have prioritized the inclusion of racially- and ethnically-diverse populations; yet, approximately 6% of participants in federally funded clinical trials are Black or Hispanic.[1,2] Despite evidence suggesting race and ethnicity are important factors in responses to environmental exposures, drug therapies, and disease risk, few studies focus on minority health needs.[3] This has, in turn,
contributed to race- and ethnicity-related differences in survival and healthy life expectancy in the United States.\(^4\)\(^,\)\(^5\)

As adults are living longer with diseases and disabilities, a large proportion of healthcare expenses come from persons with such health conditions.\(^6\) For example, approximately 86% of older adults in the United States are living with at least one health condition, and certain races and ethnicities are living with more conditions than others.\(^7\) The increased risk for morbidity seen in racially- and ethnically-diverse aging adults, specifically Blacks and Hispanics, is often attributed to differences in socioeconomic status and lack of adequate healthcare accessibility for these populations.\(^8\)

Disability-adjusted life years (DALYs) are used worldwide as a measure of population health to separately evaluate the burden of non-fatal and fatal health outcomes.\(^9\) The burden of various diseases, disabilities, and injuries are monitored over time and compared across populations. For example, ischemic heart disease contributes to the greatest number of DALYs in the United States; whereas, diabetes contributes to the greatest number of DALYs in Mexico.\(^10\) Although this time-based metric quantifies the burden of a health condition in a population and compares it to an ideal population that reaches full healthy life expectancy, the burden of many health conditions has yet to be quantified for a nationally-representative sample of middle-aged and older adults in the United States.

Assessments of DALYs provides insights regarding the burden of health conditions across growing, racially- and ethnically-diverse aging populations.\(^11\) Understanding this information will help to inform the allocation of health-related expenditures, interventions aiming to improve health in aging adults, strategies for a more inclusive healthcare system, and healthcare providers working directly with these populations. Therefore, the purpose of this study was to determine the burden of 10 health conditions across race and ethnicity for a nationally-representative sample of aging Americans.

2. Methods

2.1. Participants

Data from 37,495 participants in the 1998 to 2014 waves of the Health and Retirement Study (HRS) who identified as Black, Hispanic, or White were used for this secondary analysis. Cleaned and standardized RAND HRS data were merged with other individualized data files from the HRS. The HRS is a longitudinal-panel study that aims to understand shifts in the health status of aging adults and observe economic circumstances associated with aging at individual- and population-levels.\(^12\) Since 1992, HRS participants have been re-interviewed biennially. Beginning in 1998, the HRS has provided data for a nationally-representative sample of adults aged over 50 years, including surveys from approximately 23,000 households. Participants from the HRS are followed longitudinally until death and new cohorts of participants have been added to the original sample to maintain a national representation of the survey over time. The HRS uses a multi-stage probability design, including geographical stratification and oversampling of certain demographics groups (Blacks and Hispanics). Sample weights are provided by the HRS to account for the multi-stage, area probability design. More details for the HRS are described elsewhere.\(^13\)

Exclusions occurred for missing sex or race (n = 134), no participation in the 1998 to 2014 waves (n = 3,986), missing, other, or non-Hispanic ethnicity (n = 992), and entry age <50 years (n = 2,282). Written informed consent was obtained from all participants in the HRS prior to entering the study. Protocols were approved by the University of Michigan Behavioral Sciences Committee Institutional Review Board (HUM00061128 approved through October 18, 2018).\(^14\) Data from the HRS contain no direct identifiers, thereby ensuring participant anonymity. All data used in this investigation were publicly available.\(^15\)

2.2. Measures

2.2.1. Health conditions. At each wave, interviewers asked participants questions related to their physical health. Participants self-reported physician diagnoses for the following conditions: cancer, chronic obstructive pulmonary disease (COPD), congestive heart failure, diabetes or high blood sugar, back pain, high blood pressure or hypertension, a fractured hip, a heart attack or myocardial infarction, rheumatism or arthritis, and stroke. The wave a health condition was first reported by participants was considered a proxy for the date of diagnosis. These health conditions were selected by the investigators because they were identified as having a corresponding disability weight from the Global Burden of Disease, which is required for calculating DALYs.\(^16\)\(^,\)\(^17\)

2.2.2. Mortality. Date of death was observed through linkage to the National Death Index. Exit interviews were performed with a surviving spouse, child, or other informant to collect information about medical expenditures, family interactions, outlook of assets after death, and other circumstances that may have occurred toward the end of life. Mortality validation for the HRS has demonstrated that the National Death Index and post-mortem interviews capture 99% of participant deaths.\(^18\)

2.3. Statistical analysis

Descriptive information was reported as mean±standard deviation for continuous variables and frequency (proportion) for categorical variables. Guidelines from the World Health Organization were used for determining DALYs.\(^19\) Participants were first stratified by race and ethnicity, then within each race and ethnicity, participants were stratified into age categories (50–59 years, 60–69 years, 70–79 years, ≥80 years). The age at which a health condition occurred determined the age categories for participants.

Years lost due to disease/disability (YLD) were calculated by taking the product of the number of incident cases for each health condition, corresponding disability weight, and mean duration of years lived with the condition until death, or truncation. For participants who were still living or lost to follow-up (i.e., truncation), the mean duration of years lived with the condition was determined using their estimated life expectancy at age of truncation.\(^20\) Disability weights for each condition were from the Global Burden of Disease (back pain = 0.020, cancer = 0.288, COPD = 0.019, congestive heart failure = 0.201, diabetes = 0.015, fractured hip = 0.058, hypertension = 0.246, myocardial infarction = 0.439, rheumatism or arthritis = 0.199, stroke = 0.266).\(^16\)\(^,\)\(^17\) For each race and ethnicity, the YLDs were summed across age categories to determine total YLDs.

Years of life lost (YLL) were calculated by multiplying the number of deaths that occurred by the mean life expectancy at age of death in years. Life expectancy for males and females at
each age was determined from the Period Life Table. The YLLs were summed across age categories to determine total YLLs for each race and ethnicity.

For each race and ethnicity, YLDs and YLLs were summed across age categories to determine DALYs, then the total DALYs for each age category were summed to determine the overall DALYs for each condition. The overall number of DALYs for each health condition were sorted from largest-to-smallest and ranked for each race and ethnicity in order to compare DALY estimates across ethnicities. Sample weights were utilized in the analyses to allow DALY comparisons across race and ethnicity at the population-representative level. The YLLs, YLDs, and DALYs are reported in thousands. All analyses were performed with SAS 9.4 software (SAS Institute; Cary, NC).

3. Results

The non-weighted and weighted descriptive characteristics of the participants are presented in Table 1. There were 5510 Blacks (weighted sample = 13,169,445), 3423 Hispanics (weighted sample = 10,045,723), and 21,168 Whites (weighted sample = 91,395,572) that were included. Black, Hispanic, and White participants entered the study at 61.2 ± 9.9, 60.1 ± 9.0, and 64.4 ± 10.8 years of age, respectively. During the study, there were 1722 (31.2%) Black, 752 (21.9%) Hispanic, and 8030 (37.9%) White participants that died. Table 2 provides person-level DALY estimates and 95% confidence intervals for each health outcome.

Figure 1 presents the burden of each health condition for Blacks. Weighted DALY estimates were 1405 for hip fractures, 7660 for myocardial infarction, 8970 for congestive heart failure, 9307 for COPD, 13,834 for cancer, 15,286 for stroke, 20,391 for diabetes, 24,740 for back pain, 41,397 for arthritis, and 55,631 for hypertension. Collectively, there were an estimated 158,889 YLLs, 39,735 YLDs, and 198,621 DALYs for the 10 health conditions in Blacks.

The burden of each health condition for Hispanics is displayed in Figure 2. Weighted DALY estimates were 931 for hip fractures, 3722 for congestive heart failure, 4121 for COPD, 5235 for myocardial infarction, 6103 for stroke, 7336 for cancer, 11,703 for diabetes, 12,132 for back pain, 21,737 for arthritis, and 28,442 for hypertension. In total, there were an estimated 74,644 YLLs, 23,099 YLDs, and 101,462 DALYs for the 10 health conditions in Hispanics.

Figure 3 depicts the burden of each health condition for Whites. Weighted DALY estimates were 15,313 for hip fractures, 49,852 for congestive heart failure, 51,813 for myocardial infarction, 72,582 for stroke, 76,624 for COPD, 85,023 for diabetes, 120,958 for cancer, 149,149 for back pain, 270,788 for arthritis, and 295,623 for hypertension. There were an estimated 903,201 YLLs, 285,319 YLDs, and 1,187,725 DALYs for the 10 health conditions in Whites. Detailed information for the burden of each health condition stratified by race and ethnicity is in Table 3.

The total weighted DALY estimates for each health condition are presented and ranked by race and ethnicity in Figure 4. Across race and ethnicity, hypertension, myocardial infarction, rheumatism or arthritis, and back pain had the first, second, and third highest DALY ranks, respectively. The DALY ranks for stroke and congestive heart failure were higher in Blacks, than Hispanics and Whites. Myocardial infarction resulted in a higher DALY rank for Hispanics, than Blacks and Whites. The DALY ranks for cancer and COPD was higher in Whites, than in Blacks and Hispanics. DALY ranks were equal for diabetes in Blacks and Hispanics, but lower in Whites. Across races and ethnicities, hip fractures had the lowest DALY rank.

4. Discussion

The principal results of this investigation suggest that the estimated burden of certain health conditions impacted aging Blacks, Hispanics, and Whites differently. While hypertension, arthritis, back pain, and hip fractures had the same DALY ranks for each race and ethnicity, the DALY ranks for diabetes, stroke, cancer, COPD, congestive heart failure, and myocardial infarction varied across older Blacks, Hispanics, and Whites. For example, of the 10 health conditions examined, the burden of stroke was fifth highest for Blacks, sixth highest for Hispanics, and seventh highest for Whites. These results can be used to guide the distribution of health-related provisions, screening efforts and targeted interventions designed to improve health, and approaches to making health care more inclusive for racially- and ethnically-diverse aging adults.

Table 1

| Non-weighted and weighted descriptive characteristics of the participants. | Blacks          | Weighted Blacks | Hispanics       | Weighted Hispanics | Whites         | Weighted Whites |
|---|---|---|---|---|---|---|
| Age (yr) | 61.2 ± 9.9 | 60.1 ± 9.0 | 64.4 ± 10.8 | 64.4 ± 10.8 | 61.3 ± 10.3 | 61.3 ± 10.3 |
| Female (n (%)) | 3,249 (58.9%) | 7,250,754 (55.0%) | 1,849 (54.0%) | 5,160,995 (51.3%) | 11,493 (54.2%) | 46,772,021 (51.1%) |
| Died During Study (n (%)) | 1,722 (31.2%) | 3,543,699 (26.9%) | 752 (21.9%) | 1,804,347 (17.9%) | 8,020 (37.9%) | 26,606,177 (29.1%) |
| Age at Death (years) | 76.7 ± 11.5 | 74.8 ± 11.7 | 77.7 ± 11.0 | 76.2 ± 11.3 | 80.5 ± 10.1 | 79.1 ± 10.8 |
| Household Income ($) | 39,443 ± 55,249 | 42,195,723 ± 2,051,129 | 36,997,1 ± 144,831 | 44,132,1 ± 10,972,940 | 64,485 ± 99,793 | 75,456 ± 7,405,734 |

Missing observations for education completed were: 2 for Black, 1 for Hispanic, and 2 for White. Household income and education completed were listed for descriptive purposes and not part of the disability-adjusted life year calculations.
### Table 2
Estimated person-level disability-adjusted life year means and 95% confidence intervals.

|                | Arthritis | Back Pain | Cancer |
|----------------|-----------|-----------|--------|
|                | Mean      | 95% CI    | Mean   | 95% CI    | Mean   | 95% CI    |
| **Black**      |           |           |        |           |        |           |
| 50–59 Years    | 22.5      | 22.1, 23.0| 22.7   | 22.0, 23.3| 24.9   | 24.0, 25.7|
| 60–69 Years    | 15.9      | 15.5, 16.2| 15.2   | 14.7, 15.7| 17.0   | 16.4, 17.6|
| 70–79 Years    | 9.6       | 9.4, 9.8  | 8.9    | 8.5, 9.3  | 10.7   | 10.3, 11.1|
| ≥80 Years      | 5.6       | 5.4, 5.7  | 4.8    | 4.6, 5.1  | 5.7    | 5.4, 6.0  |
| **Hispanic**   |           |           |        |           |        |           |
| 50–59 Years    | 21.9      | 21.0, 22.9| 21.7   | 20.6, 22.8| 23.2   | 21.5, 24.8|
| 60–69 Years    | 15.4      | 14.9, 15.9| 15.0   | 14.3, 15.7| 16.2   | 15.3, 17.2|
| 70–79 Years    | 9.9       | 9.5, 10.2 | 8.9    | 8.5, 9.4  | 10.9   | 10.2, 11.7|
| ≥80 Years      | 5.8       | 5.5, 6.0  | 4.8    | 4.3, 5.0  | 6.0    | 5.6, 6.4  |
| **White**      |           |           |        |           |        |           |
| 50–59 Years    | 21.5      | 21.2, 21.9| 21.4   | 21.0, 21.8| 23.2   | 22.7, 23.7|
| 60–69 Years    | 15.0      | 14.9, 15.2| 14.0   | 13.8, 14.3| 16.5   | 16.3, 16.7|
| 70–79 Years    | 9.5       | 9.4, 9.6  | 8.8    | 8.7, 9.0  | 10.5   | 10.4, 10.7|
| ≥80 Years      | 5.7       | 5.6, 5.7  | 4.8    | 4.7, 4.9  | 6.2    | 6.1, 6.3  |

| Condition                   | Arthritis | Back Pain | Cancer |
|-----------------------------|-----------|-----------|--------|
| **Chronic Obstructive Pulmonary Disease** |           |           |        |
| Black 50–59 Years            | 22.8      | 21.7, 23.9| 24.0   | 23.1, 24.9| 21.4   | 20.8, 22.1|
| 60–69 Years                  | 15.5      | 14.8, 16.1| 16.7   | 16.0, 17.3| 14.6   | 14.2, 15.1|
| 70–79 Years                  | 9.1       | 8.5, 9.7  | 10.5   | 10.1, 11.0| 8.8    | 8.4, 9.2  |
| ≥80 Years                    | 4.8       | 4.4, 5.2  | 5.3    | 5.0, 5.7  | 5.1    | 4.8, 5.4  |
| **Hispanic**                 |           |           |        |           |        |           |
| 50–59 Years                  | 20.9      | 18.4, 23.4| 22.3   | 19.8, 24.8| 20.8   | 19.7, 21.8|
| 60–69 Years                  | 15.6      | 14.5, 16.7| 17.7   | 16.2, 19.2| 14.7   | 14.0, 15.4|
| 70–79 Years                  | 8.9       | 8.1, 9.7  | 10.5   | 9.8, 11.2 | 8.6    | 8.1, 9.1  |
| ≥80 Years                    | 4.7       | 4.1, 5.3  | 5.7    | 5.2, 6.2  | 4.9    | 4.5, 5.3  |
| **White**                    |           |           |        |           |        |           |
| 50–59 Years                  | 20.4      | 19.9, 21.0| 22.5   | 21.7, 23.4| 20.4   | 19.9, 20.9|
| 60–69 Years                  | 14.3      | 14.0, 14.6| 16.0   | 15.7, 16.4| 14.0   | 13.7, 14.2|
| 70–79 Years                  | 9.1       | 8.3, 9.2  | 10.3   | 10.2, 10.5| 8.6    | 8.4, 8.8  |
| ≥80 Years                    | 5.2       | 5.1, 5.3  | 5.6    | 5.5, 5.7  | 5.1    | 4.9, 5.2  |

| Condition                   | Fractured Hip | Hypertension | Myocardial Infarction |
|-----------------------------|---------------|--------------|-----------------------|
| **Black**                   |               |              |                       |
| 50–59 Years                 | 23.2          | 22.8, 23.6   | 24.7                  | 23.5, 26.0 |
| 60–69 Years                 | 15.1          | 13.7, 16.6   | 16.2                  | 16.0, 16.5 |
| 70–79 Years                 | 10.1          | 8.7, 11.4    | 10.0                  | 9.9, 10.2  |
| ≥80 Years                   | 4.9           | 4.3, 5.4     | 5.9                   | 5.8, 6.1   |
| **Hispanic**                |               |              |                       |
| 50–59 Years                 | 22.8          | 22.0, 23.6   | 22.4                  | 21.7, 23.9 |
| 60–69 Years                 | 15.8          | 13.7, 16.8   | 16.0                  | 15.5, 16.5 |
| 70–79 Years                 | 10.1          | 9.2, 11.8    | 10.0                  | 9.7, 10.3  |
| ≥80 Years                   | 5.1           | 4.3, 5.9     | 5.9                   | 5.7, 6.2   |
| **White**                   |               |              |                       |
| 50–59 Years                 | 22.1          | 21.8, 22.4   | 23.1                  | 22.5, 23.8 |
| 60–69 Years                 | 15.5          | 14.3, 16.0   | 15.5                  | 15.3, 15.6 |
| 70–79 Years                 | 9.6           | 9.2, 10.0    | 9.9                   | 9.6, 10.0  |
| ≥80 Years                   | 5.0           | 4.8, 5.1     | 6.0                   | 5.9, 6.0   |

| Condition                   | Stroke       |
|-----------------------------|--------------|
| **Black**                   |              |
| 50–59 Years                 | 23.6         | 22.8, 24.4  |
| 60–69 Years                 | 16.8         | 16.2, 17.3  |
| 70–79 Years                 | 10.8         | 10.5, 11.2  |
| ≥80 Years                   | 5.8          | 5.6, 6.1    |
| **Hispanic**                |              |
| 50–59 Years                 | 22.4         | 20.5, 24.4  |
| 60–69 Years                 | 16.7         | 15.8, 17.6  |
| 70–79 Years                 | 10.6         | 10.0, 11.2  |
| ≥80 Years                   | 6.2          | 5.8, 6.7    |
| **White**                   |              |
| 50–59 Years                 | 22.3         | 21.6, 23.1  |
| 60–69 Years                 | 16.4         | 16.1, 16.7  |
| 70–79 Years                 | 10.2         | 10.0, 10.3  |
| ≥80 Years                   | 5.9          | 5.8, 6.0    |
Figure 1. The estimated burden of each health condition for blacks. COPD = chronic obstructive pulmonary disease, Green Bars = years of life lost, Yellow Bars = years lived with disability.

Figure 2. The estimated burden of each health condition for hispanics. COPD = chronic obstructive pulmonary disease, Green Bars = years of life lost, Yellow Bars = years lived with disability.
Hypertension has been ranked as the single leading risk factor for the Global Burden of Disease. The overall increase in poor lifestyle behaviors such as high sedentary time and calorically dense diets has influenced the elevated worldwide prevalence of hypertension. These results align with our investigation which indicated the estimated burden of hypertension was highest across race and ethnicity. Rheumatism and arthritis are also highly prevalent health conditions in the United States. Approximately 50% of aging adults have been diagnosed with rheumatism or arthritis, and the prevalence of rheumatism and arthritis varies across race and ethnicity. Most people with rheumatism or arthritis also have another chronic disease, thereby contributing to why these individuals are at greater risk for all-cause mortality compared to the general population. These factors may explain why our results were compatible with the results of another investigation suggesting the burden of rheumatoid arthritis manifests with significant health consequences. Similarly, our results indicate that back pain had the third highest DALY rank across race and ethnicity. Another similar investigation revealed the burden of back pain was high in the United States for the year 2010, likely because back pain is prevalent in the growing aging population. Considering the high numbers of middle-aged and older adults with hypertension, rheumatism, arthritis, or back pain, preventing and treating these conditions should be a public health priority.

Diabetes is a chronic disease that represents a profound economic burden on the United States healthcare system, and is more prevalent in minority populations compared to Whites. For example, the risk of diabetes is 77% higher in Blacks and 66% higher in Hispanics compared to Whites; moreover, Blacks and Hispanics are 2.3 and 1.5 times more likely to die from complications of diabetes than Whites, respectively. This may explain why our findings suggest that the burden of diabetes was greater in Blacks and Hispanics than in Whites. Murray et al determined the overall burden of diabetes in 2010 was 2,557 DALYs (in thousands), further demonstrating the negative impact diabetes has on health in the United States.

Likewise, stroke risk is higher for Blacks and Hispanics compared to Whites. Particularly, the burden of disease from stroke and higher stroke-related mortality is greatest in Blacks. These results are supported by the results of the present investigation, wherein stroke had the highest DALY ranking among Blacks. Similar to stroke risk, the risk of developing congestive heart failure is higher in Blacks compared to Whites. This may also explain why our results indicated the burden of congestive heart failure had a higher DALY rank in Blacks than in Hispanics and Whites.

The results of this investigation also showed that the DALY rank for cancer was highest in Whites compared to Blacks and Hispanics. These results are inconsistent with other previous research that revealed Black men and White women may have the highest incidence rates for cancer, and Blacks have the highest mortality rate from cancer. However, it is possible that most White participants who reported having cancer may have had Melanoma, as Whites have substantially higher Melanoma incidence and mortality rates.

The age-adjusted prevalence for COPD in the United States is higher in Whites compared to Blacks and Hispanics, and COPD deaths are greatest in Whites than other races and ethnicities. Although progress in COPD prevention has been made
### Table 3
Detailed information for the estimated disability-adjusted life years of each health condition by race and ethnicity.

#### Arthritis

| Race  | Cases | Number Dead | YLLs/1000 | YLDs/1000 | DALYs/1000 |
|-------|-------|-------------|-----------|-----------|------------|
| Black |       |             |           |           |            |
| 50–59 Years | 3,900,493 | 602,612 | 12,798 | 5294 | 18,091 |
| 60–69 Years | 2,408,099 | 613,607 | 8660 | 3537 | 12,397 |
| ≥80 Years | 692,202 | 532,620 | 2447 | 716 | 3163 |
| Overall | 8,213,835 | 2,483,721 | 30,158 | 11,240 | 41,397 |
| Hispanic |       |             |           |           |            |
| 50–59 Years | 2,586,251 | 229,489 | 4710 | 3804 | 8514 |
| 60–69 Years | 1,635,386 | 323,187 | 4478 | 2615 | 7933 |
| ≥80 Years | 830,463 | 36,980 | 3,152 | 1163 | 4315 |
| Overall | 5,437,773 | 885,709 | 13,745 | 7991 | 21,737 |
| White |       |             |           |           |            |
| 50–59 Years | 22,748,095 | 2,518,965 | 50,310 | 36,759 | 87,069 |
| 60–69 Years | 16,314,426 | 3,951,026 | 53,173 | 26,644 | 79,817 |
| ≥80 Years | 12,021,749 | 6,614,907 | 53,112 | 18,334 | 71,446 |
| Overall | 57,898,274 | 18,525,041 | 182,036 | 88,752 | 270,788 |

#### Back Pain

| Race  | Cases | Number Dead | YLLs/1000 | YLDs/1000 | DALYs/1000 |
|-------|-------|-------------|-----------|-----------|------------|
| Black |       |             |           |           |            |
| 50–59 Years | 3,935,709 | 536,232 | 12,112 | 473 | 12,584 |
| 60–69 Years | 1,833,645 | 380,708 | 5759 | 229 | 5988 |
| ≥80 Years | 962,371 | 483,724 | 4261 | 123 | 4384 |
| Overall | 7,190,165 | 1,764,135 | 23,872 | 869 | 24,740 |
| Hispanic |       |             |           |           |            |
| 50–59 Years | 3,044,306 | 209,966 | 4545 | 371 | 4915 |
| 60–69 Years | 1,418,128 | 262,691 | 3913 | 154 | 4097 |
| ≥80 Years | 620,773 | 250,016 | 2215 | 78 | 2293 |
| Overall | 5,360,148 | 896,688 | 11,472 | 660 | 12,132 |
| White |       |             |           |           |            |
| 50–59 Years | 24,061,087 | 2,235,380 | 47,656 | 3334 | 50,989 |
| 60–69 Years | 12,148,731 | 2,798,819 | 38,981 | 1754 | 40,735 |
| ≥80 Years | 9,196,503 | 4,085,123 | 35,704 | 1200 | 36,904 |
| Overall | 51,206,939 | 13,304,181 | 142,305 | 6845 | 149,149 |

#### Cancer

| Race  | Cases | Number Dead | YLLs/1000 | YLDs/1000 | DALYs/1000 |
|-------|-------|-------------|-----------|-----------|------------|
| Black |       |             |           |           |            |
| 50–59 Years | 610,890 | 174,380 | 4102 | 853 | 4954 |
| 60–69 Years | 778,820 | 221,618 | 3424 | 1239 | 4663 |
| ≥80 Years | 483,035 | 256,954 | 2382 | 721 | 3102 |
| Overall | 2,137,851 | 628,120 | 10,724 | 3112 | 13,834 |
| Hispanic |       |             |           |           |            |
| 50–59 Years | 458,898 | 94,352 | 2022 | 813 | 2835 |

(continued)
|          | Cases | Number Dead | YLLs/1,000 | YLDs/1,000 | DALYs/1,000 |
|----------|-------|-------------|------------|------------|-------------|
| Hispanic |       |             |            |            |             |
| 60–69 Years | 481,274 | 122,795 | 1779 | 860 | 2640 |
| 70–79 Years | 266,060 | 90,736 | 836 | 469 | 1305 |
| ≥80 Years | 131,368 | 84,252 | 421 | 135 | 556 |
| Overall | 1,337,600 | 392,135 | 5058 | 2,277 | 7336 |
| White |       |             |            |            |             |
| 50–59 Years | 5,153,263 | 958,882 | 20,599 | 9081 | 29,680 |
| 60–69 Years | 5,923,962 | 1,896,355 | 28,076 | 10,421 | 38,497 |
| 70–79 Years | 5,795,758 | 3,039,329 | 27,091 | 9729 | 36,820 |
| ≥80 Years | 3,209,620 | 2,363,213 | 11,852 | 4108 | 15,961 |
| Overall | 20,082,603 | 8,257,779 | 87,618 | 33,339 | 120,958 |
| Black |       |             |            |            |             |
| 50–59 Years | 711,238 | 170,632 | 3878 | 68 | 3946 |
| 60–69 Years | 664,243 | 208,851 | 3215 | 73 | 3288 |
| 70–79 Years | 316,334 | 177,047 | 1605 | 32 | 1636 |
| ≥80 Years | 112,952 | 89,611 | 430 | 7 | 437 |
| Overall | 1,804,767 | 646,141 | 9128 | 1895 | 9307 |
| Hispanic |       |             |            |            |             |
| 50–59 Years | 428,456 | 69,645 | 1449 | 53 | 1502 |
| 60–69 Years | 356,952 | 89,198 | 1386 | 37 | 1423 |
| 70–79 Years | 227,527 | 97,210 | 857 | 25 | 882 |
| ≥80 Years | 100,952 | 65,876 | 306 | 7 | 314 |
| Overall | 1,113,887 | 321,929 | 3998 | 122 | 4121 |
| White |       |             |            |            |             |
| 50–59 Years | 4,910,970 | 1,016,178 | 20,685 | 693 | 21,378 |
| 60–69 Years | 4,417,988 | 1,595,050 | 22,673 | 592 | 23,265 |
| 70–79 Years | 4,127,694 | 2,514,715 | 22,641 | 446 | 23,087 |
| ≥80 Years | 2,232,582 | 1,686,139 | 8729 | 164 | 8894 |
| Overall | 15,689,234 | 6,812,082 | 74,728 | 1895 | 76,624 |
| Black |       |             |            |            |             |
| 50–59 Years | 363,424 | 145,629 | 3368 | 346 | 3,714 |
| 60–69 Years | 359,359 | 138,172 | 2177 | 343 | 2,520 |
| 70–79 Years | 266,344 | 194,233 | 1837 | 293 | 2,130 |
| ≥80 Years | 142,414 | 108,020 | 502 | 104 | 606 |
| Overall | 1,131,541 | 586,082 | 7684 | 1086 | 8970 |
| Hispanic |       |             |            |            |             |
| 50–59 Years | 176,133 | 45,601 | 962 | 222 | 1184 |
| 60–69 Years | 145,930 | 40,036 | 745 | 118 | 864 |
| 70–79 Years | 146,439 | 101,761 | 974 | 144 | 1,117 |
| ≥80 Years | 117,532 | 94,463 | 480 | 77 | 557 |
| Overall | 586,088 | 285,861 | 3161 | 561 | 3,722 |
| White |       |             |            |            |             |
| 50–59 Years | 1,145,359 | 336,467 | 7218 | 1296 | 8514 |
| 60–69 Years | 1,592,384 | 704,772 | 10,609 | 1650 | 12,259 |

(continued)
### Table 3 (continued)

#### White

| Age Group | Cases | Number Dead | YLLs/1000 | YLDs/1000 | DALYs/1000 |
|-----------|-------|-------------|-----------|-----------|------------|
| 70–79 Years | 2,396,118 | 1,607,466 | 15,158 | 2322 | 17,480 |
| ≥80 Years | 2,412,382 | 2,003,586 | 10,082 | 1517 | 11,599 |
| Overall | 7,546,243 | 4,652,291 | 43,067 | 6785 | 49,852 |

#### Black

| Age Group | Cases | Number Dead | YLLs/1000 | YLDs/1000 | DALYs/1000 |
|-----------|-------|-------------|-----------|-----------|------------|
| 50–59 Years | 2,307,618 | 434,077 | 9288 | 235 | 9522 |
| 60–69 Years | 1,545,949 | 427,618 | 6235 | 163 | 6399 |
| 70–79 Years | 763,997 | 391,021 | 3434 | 73 | 576 |
| ≥80 Years | 277,596 | 186,981 | 944 | 18 | 962 |
| Overall | 4,895,160 | 1,439,697 | 19,901 | 489 | 20,391 |

#### Hispanic

| Age Group | Cases | Number Dead | YLLs/1000 | YLDs/1000 | DALYs/1000 |
|-----------|-------|-------------|-----------|-----------|------------|
| 50–59 Years | 1,905,288 | 226,152 | 4685 | 212 | 4898 |
| 60–69 Years | 1,264,574 | 270,918 | 3966 | 131 | 4097 |
| 70–79 Years | 568,525 | 242,563 | 19,901 | 413 | 11,703 |
| ≥80 Years | 187,620 | 114,476 | 12 | | |
| Overall | 3,926,007 | 854,109 | 11,289 | 413 | 11,703 |

#### Fractured Hip

| Age Group | Cases | Number Dead | YLLs/1000 | YLDs/1000 | DALYs/1000 |
|-----------|-------|-------------|-----------|-----------|------------|
| 50–59 Years | 0 | 0 | – | – | – |
| 60–69 Years | 90,509 | 33,794 | 505 | 20 | 526 |
| 70–79 Years | 96,739 | 46,167 | 454 | 27 | 482 |
| ≥80 Years | 129,725 | 79,268 | 376 | 21 | 397 |
| Overall | 316,973 | 159,229 | 851 | 68 | 1405 |

#### Hypertension

| Age Group | Cases | Number Dead | YLLs/1000 | YLDs/1000 | DALYs/1000 |
|-----------|-------|-------------|-----------|-----------|------------|
| 50–59 Years | 5,558,640 | 819,520 | 17,739 | 9046 | 26,785 |
| 60–69 Years | 2,905,607 | 760,983 | 11,000 | 5297 | 16,297 |

(continued)
### Table 3 (continued)

#### Hypertension

|          | Cases   | Number Dead | YLLs/1000 | YLDs/1000 | DALYs/1000 |
|----------|---------|-------------|-----------|-----------|------------|
|          | 70–79 Years | 1,382,715 | 827,771   | 6891      | 2449       | 9340       |
|          | ≥80 Years    | 623,741   | 513,118   | 2,406     | 802        | 3209       |
| Overall  | 10,780,903  | 2,921,392 | 38,036    | 17,594    | 55,631     |

|          | Cases   | Number Dead | YLLs/1000 | YLDs/1000 | DALYs/1000 |
|----------|---------|-------------|-----------|-----------|------------|
|          | 50–59 Years | 3,460,688 | 282,735   | 5981      | 5905       | 11,887     |
|          | 60–69 Years | 2,071,914 | 428,224   | 6105      | 3712       | 9818       |
|          | 70–79 Years | 955,351   | 400,200   | 3300      | 1686       | 4986       |
|          | ≥80 Years    | 376,560   | 269,434   | 1241      | 510        | 1751       |
| Overall  | 6,864,513  | 1,380,593 | 16,627    | 8101      | 28,442     |

|          | Cases   | Number Dead | YLLs/1000 | YLDs/1000 | DALYs/1000 |
|----------|---------|-------------|-----------|-----------|------------|
|          | 50–59 Years | 23,728,718 | 2,678,355 | 54,209    | 44,972     | 99,182     |
|          | 60–69 Years | 16,010,127 | 4,034,066 | 54,549    | 31,845     | 86,394     |
|          | 70–79 Years | 12,580,126 | 6,748,071 | 54,452    | 23,554     | 78,007     |
|          | ≥80 Years    | 6,575,321  | 4,990,118 | 23,454    | 8586       | 32,040     |
| Overall  | 58,894,292 | 18,450,610 | 186,664   | 108,957   | 295,623    |

#### Myocardial Infarction

|          | Cases   | Number Dead | YLLs/1000 | YLDs/1000 | DALYs/1000 |
|----------|---------|-------------|-----------|-----------|------------|
|          | 50–59 Years | 333,331  | 78,617    | 1699      | 1055       | 2754       |
|          | 60–69 Years | 219,178  | 120,539   | 1322      | 529        | 1850       |
|          | 70–79 Years | 212,641  | 144,854   | 464       | 235        | 699        |
|          | ≥80 Years    | 87,763   | 438,032   | 5365      | 2296       | 7660       |

|          | Cases   | Number Dead | YLLs/1000 | YLDs/1000 | DALYs/1000 |
|----------|---------|-------------|-----------|-----------|------------|
|          | 50–59 Years | 233,204  | 83,379    | 1655      | 703        | 2358       |
|          | 60–69 Years | 174,681  | 57,762    | 845       | 410        | 1255       |
|          | 70–79 Years | 142,285  | 88,749    | 821       | 333        | 1155       |
|          | ≥80 Years    | 87,763   | 62,114    | 320       | 147        | 467        |
| Overall  | 637,933  | 438,032    | 5365      | 2296      | 7660       |

#### Stroke

|          | Cases   | Number Dead | YLLs/1000 | YLDs/1000 | DALYs/1000 |
|----------|---------|-------------|-----------|-----------|------------|
|          | 50–59 Years | 1,559,908 | 297,315   | 5916      | 5125       | 11,042     |
|          | 60–69 Years | 1,929,065 | 727,109   | 10,621    | 4717       | 15,338     |
|          | 70–79 Years | 1,988,291 | 1,204,918 | 10,615    | 5150       | 15,765     |
|          | ≥80 Years    | 1,641,456 | 1,369,168 | 6889      | 2780       | 9668       |
| Overall  | 7,118,720 | 3,598,510  | 34,041    | 17,772    | 51,813     |
in the United States.\textsuperscript{[34]} COPD remains a leading cause of death.\textsuperscript{[33]} Our results support these findings by suggesting non-fatal health loss and premature mortality from COPD ranked highest in Whites than in Blacks and Hispanics.

The “Hispanic Paradox” posits that persons with a Hispanic ethnicity have lower levels of cardiovascular disease despite having more risk factors compared to Whites.\textsuperscript{[36]} Our results show the DALY rank of myocardial infarction was higher in Hispanics compared to Blacks and Whites. This may suggest that myocardial infarctions are a more impactful health condition for Hispanics as they age. While hip fractures are common in older adults, other investigations have determined hip fracture incidence and mortality rates have declined in the United States.\textsuperscript{[37,38]} Hip fracture cases and related deaths were lowest in our investigation compared to the other health conditions examined, which explains why the DALY ranking for hip fractures was also lowest across all race and ethnicity. A similar investigation revealed there were 5964 healthy years of life lost from hip fractures in a sample of 223,880 older adults that were followed for approximately 13 years.\textsuperscript{[39]} Although the DALY ranks in this investigation were lowest for hip fractures across race and ethnicity, hip fractures remains a primary etiology of poor function and quality of life.\textsuperscript{[40]}

Indeed, our DALY estimates revealed that the burden of some health conditions impacted each race and ethnicity

| Hispanic | Cases | Number Dead | YLLs/1000 | YLDs/1000 | DALYs/1000 |
|----------|-------|-------------|-----------|-----------|------------|
| 70–79 Years | 253,290 | 126,808 | 1179 | 339 | 1519 |
| ≥80 Years | 159,546 | 116,926 | 635 | 135 | 770 |
| Overall | 1,013,026 | 416,072 | 4802 | 1300 | 6103 |

| White | Cases | Number Dead | YLLs/1000 | YLDs/1000 | DALYs/1000 |
|-------|-------|-------------|-----------|-----------|------------|
| 50–59 Years | 1,815,831 | 432,240 | 8834 | 3541 | 12,375 |
| 60–69 Years | 2,583,425 | 958,727 | 14,305 | 3890 | 18,195 |
| 70–79 Years | 3,714,046 | 2,190,842 | 18,960 | 5902 | 24,862 |
| ≥80 Years | 3,766,630 | 2,728,074 | 13,425 | 3725 | 17,150 |
| Overall | 11,879,932 | 6,309,883 | 55,524 | 17,058 | 72,582 |

DALY = disability-adjusted life year, YLD = years lived with disease/disability, YLL = years of life lost.

Figure 4. Combined weighted DALY estimates for each health condition ranked by race and ethnicity. COPD = chronic obstructive pulmonary disease, DALYs = disability-adjusted life years.
differently. These findings suggest that healthcare providers and interventions should consider the role of race and ethnicity for health. For example, continuing to develop programs that reduce racial and ethnic disparities in healthcare access and insurance coverage may help to provide more inclusive and quality healthcare.[41] Our findings suggest that hypertension accounted for the largest amount of DALYs for each race and ethnicity. Interventions aiming to prevent and improve health outcomes such as hypertension in at risk populations should include community engagement and culturally responsive strategies for behavior change initiation and adherence.[42,43] Continuing to work toward more inclusive healthcare may reduce future DALY estimates.

Some limitations should be noted. The HRS provides a rich amount of health data for aging Americans. Although some have provided evidence for the concordance between self-reported measures of morbidity and claim-based administrative data,[43] the extent of the reliability and validity for each self-reported health condition item in this study is unknown.[44,45] While the use of an incidence-based YLD calculation allowed us to evaluate how the burden of each health condition longitudinally, we were unable to control for multimorbidity in our disability weights. The authors did not exclude participants for having a cognitive impairment because the presence of these health conditions would not have changed if reported by a proxy. Being that health conditions were self-reported by participants at each wave, it is possible that our results were underestimated from recall biases. Adults over 50 years of age were included; therefore, some participants may have had health conditions at younger ages prior to entering the study, thereby causing DALYs to be underestimated. Moreover, those who were lost from follow-up or died may have had a health condition that was not reported before the event, thereby generating underestimations for our results. It is possible that participants may have disputed their records for having a diagnosis or were no longer living with a health condition after initial diagnosis. We were also unable to specify certain health conditions (e.g., cancer). Statistical tests of inference were not used for making comparisons between DALY estimates because DALYs are often presented as a stand-alone statistic. As such, other important factors that may have helped to explain the DALY estimates such as socioeconomic status could not be taken into account. Future research should continue monitoring DALYs, including the use of the prevalence-based DALY calculation so that temporal trends can be observed.

5. Conclusions

The burden of 10 health conditions accounted for millions of healthy years of life lost for Black, Hispanic, and White aging Americans. Some health conditions impacted each race and ethnic groups differently, while others remained consistent. Trends in DALYs should continue to be monitored in middle-aged and older adults so that healthcare resources are prioritized to match such trends, and for gauging the efficacy of interventions aiming to prevent and treat health conditions. This will help the efficiency of health-related expenditures, improve the impact of health interventions, advance inclusive health care for the growing aging adult population, and prepare healthcare providers for serving the health needs of aging adults.

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