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US Racial–Ethnic Mortality Gap Adjusted for Population Structure

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Background: US racial–ethnic mortality disparities are well documented and central to debates on social inequalities in health. Standard measures, such as life expectancy or years of life lost, are based on synthetic populations and do not account for the real underlying populations experiencing the inequalities.

Methods: We analyze US mortality disparities comparing Asian Americans, Blacks, Hispanics, and Native Americans/Alaska Natives to Whites using 2019 CDC and NCHS data, using a novel approach that estimates the mortality gap, adjusted for population structure by accounting for real-population exposures. This measure is tailored for analyses where age structures are fundamental, not merely a confounder. We highlight the magnitude of inequalities by comparing the population structure-adjusted mortality gap against standard metrics' estimates of loss of life due to leading causes.

Results: Based on the population structure-adjusted mortality gap, Black and Native American mortality disadvantage exceedsmortality from circulatory diseases. The disadvantage is 72% among Blacks (men: 47%, women: 98%) and 65% among Native Americans (men: 45%, women: 92%), larger than life expectancy measured disadvantage. In contrast, estimated advantages for Asian Americans are over three times (men: 176%, women: 283%) and, for Hispanics, two times (men: 123%; women: 190%) larger than those based on life expectancy.

Conclusions: Mortality inequalities based on standard metrics' synthetic populations can differ markedly from estimates of the population structure-adjusted mortality gap. We demonstrate that standard metrics underestimate racial–ethnic disparities through disregarding actual population age structures. Exposure-corrected measures of inequality may better inform health policies around allocation of scarce resources.

Keywords: Age structure; Mortality; Exposure; Racial disparities

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Racial–ethnic disparities in mortality in the United States are large and persistent, despite the recent narrowing of the gap between Black and White Americans.[1] The standard indicators for measuring and monitoring these inequalities include life expectancy and years of life lost. By design, these indicators are based either on synthetic populations in which age structure is implicitly derived from the mortality schedule of the observed population or, in the case of years of life lost, on standard populations. That is, these measures disregard differences in the actual population age structures when comparing mortality experiences across populations. This feature may be highly beneficial in contexts in which the underlying differences in real population age structures are considered a nuisance to the analysis.[2] For health policy, however, measures that account for population size and structure may be helpful in providing a signal on where to allocate scarce resources. Insofar as mortality disparities inform social and health policy priorities, and greater inequalities demand more attention, identifying the extent to which some racial groups experience a mortality disadvantage should aid in guiding policy.

Ignoring the actual age structure of populations can result in misleading conclusions in some contexts. The current COVID-19 pandemic offers a salient example, illustrated by the following thought experiment. Consider two cruise ships with populations from the same country; both cruises carry individuals from all ages, but one has a relatively young population, while the other is populated mostly by retirees. In which ship is a COVID-19 outbreak more threatening? Given that the risk of complications and death after infection increase exponentially with age,[3,4] we expect it to be the latter. However, the loss of life as measured by the life expectancy reductions would be identical. This is because changes in life expectancy are determined by the preoutbreak age-specific mortality rates and the age-specific COVID-19–related increase in mortality, which are shared across scenarios. The actual age structures play no role even though we know that, everything else equal, older populations are bound to be more heavily afflicted by the pandemic.[5] Thus, an assessment of the loss of life from COVID-19 that is based on life expectancy would not detect this age-structure–related vulnerability. This shortcoming is known,[6] but often not sufficiently acknowledged; in our analysis, we demonstrate its implications for the evaluation of racial–ethnic mortality disparities.

A key alternative summary measure to life expectancy is years of life lost (YLL), which is commonly used to assess the relative importance of specific causes of death within a population and thus guide public health interventions.[7] Years of life lost are the sum of the years between the age at which death occurs and the age at which we would expect death to occur.[8,9] Years of life lost measures are directly age standardized for cross-population comparisons, using a shared population age structure.[9] This is not without controversy, as there is no generally agreed-upon objective way to choose the standard population, and results may vary strongly depending on the standard,[10] affecting not only the magnitude of disparities but even their direction.[11] The limitations of direct standardization have been acknowledged to be particularly relevant in racial inequality assessments, given the existing differences in age structures across racial–ethnic groups.[12,13] Thus, direct standardization is a partial solution at best.

These two approaches feature prominently in the current literature on population-level racial–ethnic mortality disparities. Life expectancy differences have been frequently used to evaluate US trends in racial–ethnic mortality disparities,[1,14–16] as well as its geographic patterns.[17] This approach has also been applied to document the disproportionate impact of the COVID-19 pandemic on racial–ethnic minorities in the United States,[18] resulting in greater life expectancy disparities.[19] In turn, years of life lost have been used to assess the cause-specific differentials in mortality that result in the overall racial–ethnic mortality disparities. More recently, this framework has also been applied to assess loss of life inequalities during the pandemic.[20,21] This aligns with prior work that evaluates contributions of leading causes to racial–ethnic disparities using YLL,[22] as well as more targeted work that has focused on specific causes of death and risk factors, such as alcohol consumption,[23] cancer,[24] and skin cancer,[25] HIV,[26] among others. All of the above rely either on direct standardization, often based on the 2000 US standard population or, in the case of life expectancy, synthetic population structures that are implied by mortality rates.

We propose a novel measure for evaluating mortality inequalities that accounts for the actual age structures of the populations. Our starting premise is that mortality rate differences are based on mutable social inequities, such as material deprivation or unequal access to care. Based on this, we suggest a counterfactual approach that is closely related to existing methods, such as indirect standardization and well-established decomposition approaches.[27] We formulate the counterfactual by asking to what extent mortality conditions would improve or worsen for a given racial–ethnic population, given their age composition, if they were to experience non-Hispanic White age-specific mortality rates (our baseline). From a technical perspective, we differ from previous studies that assess racial mortality inequality using indirectly standardized measures by differentially weighting deaths by remaining life expectancy.[28]

However, we believe our primary contribution is conceptual. We explicitly analyze the role of age composition, whereas the literature is dominated by approaches that treat age composition purely as a confounder. Current age-structure–related adjustments implicitly or explicitly use age structures that differ from those of real populations. This is clearly the case for measures based on direct standardization, but it also applies to life expectancy comparisons. The life table contains an implicit population age structure; that is, the age structure that would occur for a population with current mortality rates and no growth rate (just replacement). In that sense, life expectancy can be interpreted as the mean age at death of that synthetic population. These deviations from real population age structures come at a cost, as illustrated by the examples in this introduction.

We employ a life table approach, similar to much of the literature on racial–ethnic mortality differentials. Accordingly, exposures are defined as the population at risk of dying during an age interval, measured in person years. The main difference is that our adjustment procedure then corrects for the age structure of the real population by using its age-specific exposures and weighting mortality risks accordingly; that is, our method is exposure-corrected. That is, while other methods are based on synthetic populations, our correction uses the actual population age structure in the definition of the at-risk populations. Exposure adjustments are especially relevant in the assessment of racial–ethnic mortality disparities given the substantial differences in age structures across racial–ethnic groups.

We demonstrate this new measure with a case study evaluating contemporary mortality inequalities in the United States among Hispanics, non-Hispanics who are American Indian/Alaska Native (AIAN), Asian American, non-Hispanic Blacks, and non-Hispanic White. To highlight the magnitude of the differences among measures, we compare our measure of exposure-corrected inequalities to the inequalities estimated when using life expectancy and standardized years of life lost. Our findings suggest that standard demographic indicators underestimate the mortality inequalities in the United States because they disregard actual population age structures when comparing mortality experiences across populations. The results based on the novel indicator, which we call the gap adjusted for population structure, suggest that inequalities are substantially larger than standard demographic methods would imply.

METHODS

Standard Measurement of the Racial–Ethnic Mortality Gap

The object of interest of this study, the racial–ethnic mortality gap, is measured as the difference between given mortality indices across two racial–ethnic groups (*A*, *B*). For life expectancy, this is simply:

$$\Delta e_0^{A,B} = e_0^A - e_0^B, \tag{1}$$

where e_0^G stands for the life expectancy at birth of group *G*. Another common strategy is based on the years of life lost (YLL) framework.[8,9] While typically YLL are used to assess cause-related mortality, they can also be utilized to assess the mortality gaps. The standard approach calculates YLL per death as the difference between the age at death and remaining life expectancy at that given age. At a population level, they are often expressed in rates (per 100k):

$$\text{YLL}_G = \sum_x m_x^G \cdot\ e_x \cdot\ C_x^G \cdot 100{,}000, \tag{2}$$

where m_x^G, e_x, C_x^G are the mortality rates, standard remaining life expectancy (based on some standard; we use best practices, more details on that in the data section), and exposures at age x, respectively. In cross-population comparisons a reference standard population (C_x^s) is often used; we denote this variant of YLL the sYLL. Based on sYLL the mortality gap between two populations is as follows:

$$\Delta\text{sYLL}_{A,B} = \text{sYLL}_A - \text{sYLL}_B \tag{3}$$

A Counterfactual Approach to Mortality Inequality

We propose a counterfactual method to the measurement of mortality disparities. The basic idea, in the spirit of indirect standardization methods, consists of measuring the disparity between a population A and its reference B as the mortality change for A that would result from attaining B's mortality rates while holding constant A's age structure. We embed this calculation in the standard years of life lost (YLL) approach. We call this indicator the gap adjusted for population structure (GAP). We operationalize this idea in the following manner. Instead of using direct age-standardized YLL (sYLL), we compute a counterfactual YLL ($_c$YLL), with A's age structure and B's mortality rates.

$$\text{cYLL}_A = \sum_x m_x^B \cdot\ e_x \cdot\ C_x^A \cdot\ 100{,}000 \tag{4}$$

Then, we measure the mortality gap as the difference between cYLL and the actual YLL, that is, the YLL at both A's current mortality rates and age structure of exposures; that is, the GAP (ΔcYLL) is the difference between (2) and (4).

$$\Delta\text{cYLL}_{A,B} = \text{YLL}_A - \text{cYLL}_A = \text{GAP}_{A,B} \tag{5}$$

Thus, a positive GAP (5) shows how many years of life are lost (a "disadvantage") and a negative GAP how many years are gained (an "advantage") relative to a reference population's mortality. This age-structure–dependent measure of mortality differences can then be used as the foundation to study the racial–ethnic mortality disparity, without arbitrarily choosing a population for (direct) age standardization.

Similar counterfactual approaches are frequently used in demography, epidemiology, and public health. Our proposal follows the logic of indirect standardization methods.[29] Indirect standardization measures, such as the standardized mortality ratio (SMR), compare observed death counts to a counterfactual based on the actual population age structure and the reference population's mortality rates. We embrace this approach, which is often but not exclusively used in data-sparse situations, and extend it to consider the age gradient of the loss of life accrued by deaths. That is, the loss of life accrued to age-specific deaths in our measure is based on remaining life expectancy, whereas the SMR implicitly weights each death equally (regardless of age). How can these counterfactual mortality rates be understood? Mortality disparities are rooted in mutable social inequities, such as socioeconomic disparities and racial discrimination. For example, the approximately double infant mortality rates Blacks suffer compared with Whites[30] have been tied to access to care,[31] race-related biases at treatment,[32] and other social factors.[33] Thus, it is conceivable that disadvantaged racial–ethnic groups might achieve the lower mortality rates of the more advantaged. This is our counterfactual.

Intuitively, there may be a tendency to place more importance on mortality risks affecting larger fractions of the population. In the infant mortality rate example above, for a group with a young population with high fertility rates, reducing infant mortality could represent a greater reduction in loss of life than improving mortality rates at the upper end of the mortality distribution. And the contrary could be true for a relatively older population group, as in the COVID-19 example above, where focusing more resources on COVID-19 prevention and treatment could lead to fewer YLL. Thus, adjusting for the actual age structure of the population may lead to a greater understanding of how to prioritize public health interventions to reduce loss of life. Our measure, the population structure-adjusted mortality gap, allows us to evaluate these trade-offs.

Comparisons to Other Approaches

To compare our results with those from existing methods measuring the mortality gap using life expectancy (Δe_0) or standardized YLL (ΔsYLL), we normalize each measure by dividing it by the (race–ethnicity specific) loss of life from leading causes of death. Note that this normalization is not necessary for interpreting the population structure-adjusted mortality gap alone, but this is useful for comparative purposes. First, it serves as a reference for the magnitude of the population structure-adjusted mortality gap,[2] by comparing it with important causes of death with which we are already familiar. Second, it facilitates the comparison of the gap across metrics that use different units of measure. The importance of these causes of death within a racial–ethnic group is assessed using standard approaches; for e_0, we use a cause-deleted life table approach[11] and for YLL, we compute the YLL associated with each cause of death.[8,9]

The population structure-adjusted mortality gap measures mortality gaps through counterfactuals based on examining actual populations with alternative mortality rates. In contrast, both Δe_0 and ΔsYLL evaluate the mortality disparities for counterfactuals based on synthetic populations with actual mortality rates. In the case of ΔsYLL, it captures the mortality inequalities that would exist should all races/ethnicities share the age structure of a reference population (e.g., the US standard population). In turn, Δe_0-based assessments can be given a population interpretation, whereby differences in life expectancy at birth between specific populations are the disparity in mean ages at death in their respective stationary populations. Therefore, both approaches evaluate mortality disparities in synthetic or theoretical populations which may not reflect the disparities that occur in the actual populations.

Figure 1 illustrates the differences in age structure by race–ethnicity and gender between the real US population and the US standard and the life table populations. For instance, compared with the actual age distribution of the total White population in 2019, the proportion of those under one year of age is 39% and 27% larger in the US standard and life table populations, respectively. Asian American, AIAN, Hispanic, and Black actual populations are younger than the standard and life table populations suggest (more so in the Asian American and Hispanic cases), whereas the reverse is true for Whites. The gender-specific age structures show patterns that are, generally speaking, aligned with those of their respective racial–ethnic groups.

Data

We retrieved life tables for year 2019 by single year of age, sex, race, and Hispanic origin from the National Center for Health Statistics (NCHS) Life Tables website's public files.[34] We obtained death counts for 2019 by cause, single year of age, sex, and bridged race and Hispanic origin from the Underlying Cause of Death data, available through the CDC WONDER Online Databases.[35] We defined causes of death following the 10th revision of the International Statistical Classification of Diseases (ICD-10). We used the US standard population and US population estimates by single year of age (0, 1, 2,…, 85 years and over), abridged race, Hispanic origin, and sex, on 1 July 2019, from the abridged-race intercensal estimates of the resident population of the US website.[36] We used the WHO's standard life expectancies by single year of age and a 85+ open-ended age interval.[8,9] For exposure adjustment, we used age-specific exposures taken from the Human Mortality Database,[37] and combined them with the racial–ethnic distribution by age to calculate race- and age-specific exposures. This analysis using publicly available data did not require ethical review.

Application

We used the population structure-adjusted mortality gap to reanalyze contemporary racial–ethnic mortality inequalities in the United States. We compare non-Hispanic American Indian or Alaska Native, non-Hispanic Asian Americans, non-Hispanic Blacks, non-Hispanic Whites, and Hispanics (irrespective of race) to non-Hispanic Whites (each group compared with non-Hispanic Whites). We use circulatory diseases (ICD codes I00-I99), the leading cause of death in the United States, for normalizing disparities. The Table displays all the elements of these calculations and the results. We divide the mortality difference calculated according to each approach (Table, column 4) by the loss of life from a cause of death (Table, column 5). For Blacks, the normalized mortality disparity is interpreted as follows: the mortality disadvantage of Blacks compared with Whites represents X times as much loss of life as circulatory diseases. That is, from the perspective of Blacks, achieving White mortality across all ages would result in an overall reduction in loss of life X times the gain from eliminating circulatory diseases. Realistically, the former intervention would likely involve improving in a variety of causes of death. Hispanics and Asian Americans have lower mortality than Whites, so the ratio captures the mortality advantage of Hispanics and Asian Americans. We calculate similar relative metrics based on Δe_0 and ΔsYLL. In addition to circulatory diseases, we also normalize disparities with the following four leading causes of death in the United States: cancers (ICD codes C00-D48), external causes (V01-Y89), respiratory diseases (J00-J98), and diseases of the nervous system (G00-G98).

RESULTS

Figure 2A shows the mortality disparity for all groups except Whites (our baseline) based on life expectancy (Δe_0), the direct age-standardized (using the US standard population) YLL (ΔsYLL), and the population structure-adjusted mortality gap (ΔcYLL). Each point represents the ratio of the racial–ethnic disparity to the gains from removing circulatory

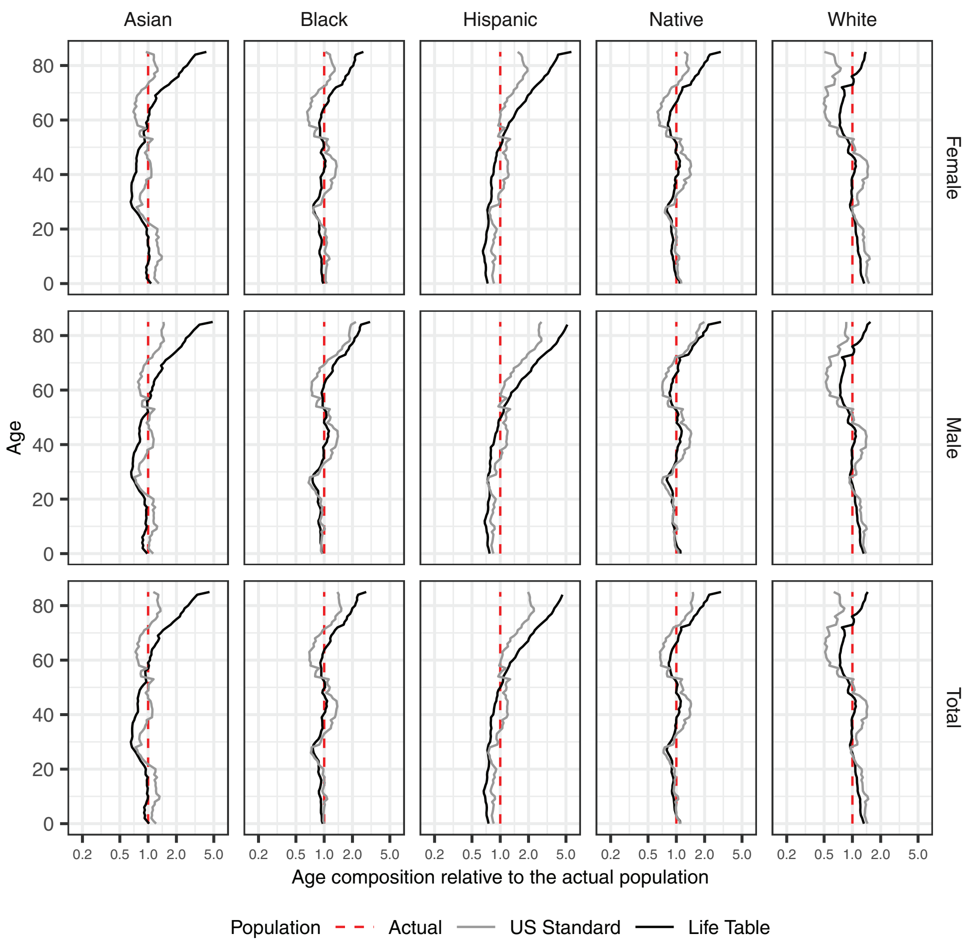

FIGURE 1. Deviations from the actual age distribution (2019).

diseases. We find that, across race–ethnicity and gender, mortality disparities based on GAP are larger than those captured by Δe_0.

The Black/White disparity in Δe_0 is two thirds (0.67) the size of the loss of life expectancy from circulatory diseases for the total Black population. However, based on YLL—both ΔsYLL and population structure − adjusted mortality gap—the racial disadvantage is as deadly as the leading cause of death (1.07 and 1.15). That is, the Black/White racial disparity is 72% (1.15/0.67) larger based on our approach. In the same way, AIAN/White disparities, already deadlier than circulatory diseases according to Δe_0 (1.5), increase 65% (2.48/1.5) based on the GAP.

For racial–ethnic groups with a mortality advantage over Whites, the disparities are also markedly larger as measured by the population structure-adjusted mortality gap. The Hispanic mortality advantage based on ΔsYLL and GAP (1.24 and 1.39) is more than two times larger than what the Δe_0-based metric implies (0.57). In the case of Asian Americans, the mortality difference as measured by population structure-adjusted mortality gap (3.85) is more than triple the amount Δe_0 indicates (1.19), with respect to the loss of life from circulatory diseases.

In some cases ΔsYLL and population structure-adjusted mortality gap differ substantially. For instance, for Hispanic men compared with White men, ΔsYLL indicates that ethnic disparities are roughly as deadly as circulatory diseases (1.01), while the population structure-adjusted mortality gap indicates that ethnic disparities are considerably larger (1.18). The extent to which real age structures differ from those of the life table or the standard population plays a role in the differences between methods, with larger deviations in age structures resulting in larger disparities in the resulting gaps. The Asian American, Hispanic, and AIAN populations deviate the most (across races/ethnicities) from synthetic age structures, and we find large differences between our method and existing approaches.

Gender-specific Results

When interpreting race–ethnicity and gender-specific results, we note that the difference-to-cause ratio will depend on both the gender-specific importance of the reference cause of death and of the gender racial mortality gap itself. Thus, for a given racial–ethnic group, a given gender may have a larger mortality gap, but a smaller difference-to-cause ratio. This is not a limitation intrinsic to the population structure-adjusted

TABLE. Life Expectancy (Δe_0), Standardized YLL (ΔsYLL), Population Structure-adjusted Mortality Gap (GAP) for: the Racial Gap Between Each Race and Whites (Column 4), the Loss of Life from Circulatory Diseases for Each Race (Column 5), and the Ratio of the Two (Column 6)

Race	Gender	Metric	Mortality Difference	Gain from Circulatory Diseases Elimination	Ratio of Mortality Difference to life Loss Circulatory Diseases
Asian	Female	Δe_0	−6.17	5.74	1.07
		ΔsYLL	−6,452.88	1,624.44	3.97
		GAP	−6,919.50	1,688.27	4.10
	Male	Δe_0	−7.12	5.53	1.29
		ΔsYLL	−9,733.46	2,987.21	3.26
		GAP	−9,690.15	2,718.56	3.56
	Total	Δe_0	−6.79	5.72	1.19
		ΔsYLL	−8,073.29	2,232.05	3.62
		GAP	−8,355.41	2,172.03	3.85
Black	Female	Δe_0	3.16	6.04	0.52
		ΔsYLL	4,875.13	4,841.84	1.01
		GAP	5,150.98	5,023.60	1.03
	Male	Δe_0	5.01	5.66	0.88
		ΔsYLL	9,369.15	8,193.86	1.14
		GAP	9,425.65	7,294.22	1.29
	Total	Δe_0	3.99	5.98	0.67
		ΔsYLL	6,753.40	6,330.30	1.07
		GAP	7,012.41	6,115.05	1.15
Hispanic	Female	Δe_0	−3.17	5.39	0.59
		ΔsYLL	−3,350.31	2,170.04	1.54
		GAP	−2,722.47	1,595.72	1.71
	Male	Δe_0	−2.73	5.15	0.53
		ΔsYLL	−3,974.91	3,918.96	1.01
		GAP	−2,997.18	2,546.89	1.18
	Total	Δe_0	−3.08	5.42	0.57
		ΔsYLL	−3,702.54	2,975.08	1.24
		GAP	−2,875.87	2,069.03	1.39
Native	Female	Δe_0	6.31	4.40	1.43
		ΔsYLL	11,178.17	4,058.96	2.75
		GAP	11,214.59	4,087.90	2.74
	Male	Δe_0	7.69	4.77	1.61
		ΔsYLL	16,086.81	7,338.55	2.19
		GAP	16,116.01	6,881.70	2.34
	Total	Δe_0	7.03	4.67	1.50
		ΔsYLL	13,494.89	5,599.07	2.41
		GAP	13,535.15	5,459.49	2.48

In the case of Asians and Hispanics, the mortality gap is negative (advantage), whereas for Blacks and AIAN it is positive (disadvantage).

mortality gap, but rather a consequence of the normalization undertaken to facilitate the interpretation of the magnitudes with respect to other approaches. This consideration plays a role in the gender-specific results across races/ethnicities.

For this reason, direct comparisons of the mortality difference (Table, column 4) across genders were also informative. We found, based on the population structure-adjusted mortality gap, that the mortality advantage for

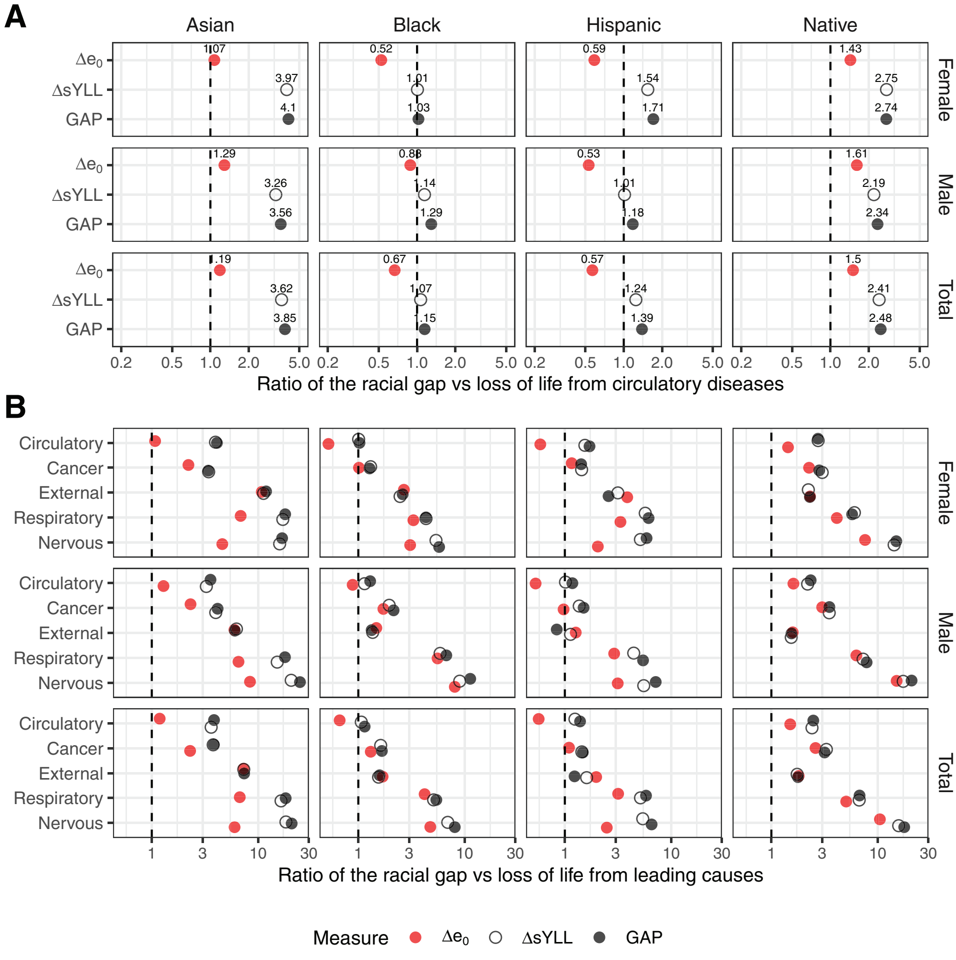

FIGURE 2. Mortality gap based on life expectancy (Δe_0), standardized YLL (ΔsYLL) and the population structure-adjusted mortality gap (GAP). A, The racial/ethnic disparity for females, males, and total in relation to circulatory diseases. B, Racial/ethnic disparity for females, males, and total using other causes of death (top 5 causes) as a reference.

Asian Americans and Hispanics was larger for males than for females, and the mortality disadvantage for Blacks and AIAN was more pronounced for males. This is aligned with the findings based on Δe_0 for most racial–ethnic groups, with the exception of Hispanics. The Hispanic mortality advantage as measured by GAP (Table, column 4) was larger for males than for females (−2,997 and −2,722, respectively), whereas an evaluation based on Δe_0 indicates that males (−2.73) had a smaller life expectancy advantage over females (−3.17).

Nonetheless, an analyst may also be concerned with the magnitude of the gender-specific racial gap with respect to the within gender circulatory diseases mortality; that is, the difference-to-cause ratio (Table, column 6). Overall, results based on the population structure-adjusted mortality gap indicate larger disparities than those based on Δe_0 for both genders. In that regard, the mortality advantage for Asian Americans over Whites was 283% larger (4.10/1.07) for females and 176% larger (3.56/1.29) for males, than the disadvantage as measured by Δe_0. Similarly, the Hispanic advantage is 190% (1.71/0.59) larger for females and 123% (1.18/0.53) larger for males than life expectancy-based disparities would imply. For racial–ethnic groups experiencing a mortality disadvantage, we also found larger disparities based on GAP. The Black mortality disadvantage was also larger based on GAP, 47% (1.29/0.88) for males and 98% (1.03/0.52) for females. Finally, we found similar patterns for AIAN, with larger disadvantages for both males, 45% (2.34/1.61), and females, 92% (2.74/1.43).

Comparison to Other Leading Causes of Death

In Figure 2B, we normalized by the five leading causes of death in the United States to assess whether our results are idiosyncratic for circulatory disease or demonstrative of a pattern. We find that racial–ethnic disparities based on existing approaches (Δe_0, ΔsYLL) are smaller across almost all causes of death. The only exception was external causes, particularly for Hispanics, for which the disparity was larger based on Δe_0 than on our approach. This is because, as with racial–ethnic disparities, loss of life due to external causes is also underestimated by current approaches, especially for Hispanics. This is because it is the combination of a cause with higher mortality at early ages and a considerably younger subpopulation than the US standard or life table populations suggest (Figure 1).

The size of the mortality difference, as measured by other leading causes of death, varies substantially by race–ethnicity and gender. However, the magnitude of the differences we report are similar, across racial–ethnic groups, for the case of respiratory diseases, and even more so for nervous diseases (Figure 2). That is, the magnitude of the disparity is not uniquely high for circulatory diseases.

DISCUSSION

Using NCHS, CDC, WHO, and HMD data, and a novel counterfactual-based measure, we studied contemporary racial–ethnic mortality disparities in the United States. Our results show that racial–ethnic mortality evaluations that account for actual exposures indicate larger mortality disparities than analyses based on mortality rates and their implied age structure, such as life expectancy. Based on our exposure-corrected measure, the population structure-adjusted mortality gap, we find a larger Black/White (72%) and AIAN (65%) mortality disadvantage, and a greater Asian American (224%) and (144%) Hispanic mortality advantage than what life expectancy-based calculations would imply. These disparities are also larger than the results obtained using standardized years of life lost measures, indicating that using real age structures instead of standard age structures identifies greater racial–ethnic mortality disparities in the US context.

Our measure complements existing approaches to estimate mortality trends and disparities; ultimately, the best approach depends on the question. We have posited that exposures ought to play a central role in understanding population-level disparities, and as such, the population structure-adjusted mortality gap is particularly well suited to studying racial–ethnic mortality inequalities. The focus on exposures might not always be warranted. Age-specific life expectancies are commonly used as population-based estimates of remaining life years for actuarial calculations, such as the ones involved in the forecasts of pension expenditures.[38] In trying to understand and model individual behavior (e.g., savings decisions), individual survival probabilities play a central role.[39] Finally, we might want to hold age structures constant in assessing temporal trends in issues such as the burden of disease, as to assess the improvement of condition-specific mortality rates.[40] Our approach is thus tailored for analyses in which age structures are a fundamental component, not merely a confounder.

Similarly to existing approaches, a shortcoming of our approach is that we do not consider the effect that changing mortality rates could have on age structures. This is clearly the case for ΔsYLL, because direct age standardization assumes that different mortality rates can coexist with an identical age distribution. It might appear that Δe_0 does not suffer FROM this shortcoming. Indeed, in the calculation of e_0, the age structure is implicitly derived from the mortality rates. However, the implicit age structure of the life table is based exclusively on mortality rates, and thus does not represent a realistic approximation of the age structure under alternative mortality distributions.

Beyond technical considerations, the approaches to mortality evaluation we have presented also correspond to distinct perspectives on racial–ethnic equity in mortality. The underlying notion of equity behind Δe_0-based analysis is that equality will be achieved when any two individuals born in the same birth cohort in the United States, regardless of race–ethnicity, have the same life expectancy. Alternatively, we have presented a different version whereby equality implies that, given their age structure, no race–ethnicity would be better off exchanging their mortality rates with those of any other race–ethnicity. The two notions are not equivalent, as we have illustrated in this work, and thus can lead to different recommendations for policies that pursue the reduction of disparities. Given that both approaches have similar data requirements and analytical complexity, the preferred approach will depend on the research question.

CONCLUSIONS

The purpose of this piece is to introduce a new approach to measuring mortality disparities. The population structure-adjusted mortality gap explicitly incorporates actual age structures in cross-population analyses. We also compare this measure to the disparity found using two common alternatives—life expectancy and years of life lost. Other indicators that quantify additional dimensions of mortality and health disparities might benefit from insights from this work, such as measures of life table-based longevity like the median and modal ages at death[41] and lifespan inequality indices.[42] Other measures, such as quality adjusted life-years (QALY), often used in policy evaluations,[43] consider the disability status of years lived. Although these measures provide additional insights on racial–ethnic mortality disparities beyond those covered by our approach, the exposure-related considerations at the core of our contribution also apply. Exploring the quantitative implications of incorporating exposure corrections into these measures represents an interesting potential avenue for future research.

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