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May 7, 2021

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Dear Dr. Loder:

We thank the editors and reviewer for examining our manuscript and for offering to reconsider a revised draft. We have carefully addressed the comments, which were quite helpful in improving the paper. Of particular benefit was your request to provide estimates for life expectancy for the run-in period earlier in the decade and to extend the estimates beyond 2017. These changes helped us present a more compelling case for the study's major finding, that the decline in US life expectancy in 2020 was extraordinary. The new information is presented in Figure 1, which vividly displays the gap in life expectancy that existed when the decade began, the widening of the gap that followed as the decade progressed, and the massive decrease in life expectancy that occurred in 2020.

It took some time to obtain the vital statistics for the intervening years and rerun the model, so we took the opportunity to update the 2020 death data so that the results in this paper are as current as possible. Death counts for 2020 were already very complete in our original submission, but additional 2020 data continued to trickle in to the CDC and the Human Mortality Database while the paper was under review. Our updated estimates changed very little from the results in our first draft, which adds to our confidence that our findings are robust. Also during this period, one of us (SHW) published in *JAMA* the third of a series of studies on excess deaths in 2020 related to the COVID-19 pandemic; this comes up below with respect to review comments about non-COVID deaths.

Before we review our responses to each individual comment, we would like to address three important themes as background for our responses: (1) the importance of cross-national comparisons, (2) the true meaning of life expectancy, and (3) the importance of systemic racism.

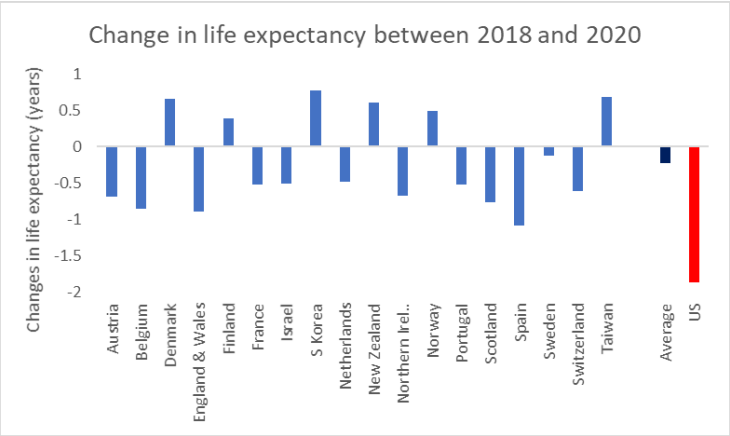
Cross-national comparisons: This project and its estimate of 2020 life expectancy addressed two primary research questions:

(1) Did changes in US life expectancy differ from those of other high-income (peer) countries, and by how much?
(2) In the United States, how large were the racial/ethnic disparities in the loss of life expectancy?

The editors' suggestion to remove the cross-national comparison, the first of these research questions, is therefore problematic. The question is very important. Health policy in many countries has benefited from cross-national comparisons undertaken by major agencies like the WHO and OECD. Comparing our outcomes with peer nations is less common in the United States, where a culture of "American exceptionalism" resists comparisons with other countries, clinging to the belief that the US population is unique and the myth that its health statistics are equivalent, if not superior, to those of its peers. The facts suggest otherwise: a small but important series of studies over the past 15 years, including two major reports by the National Academy of Sciences (Woolf and Aron 2013; NASEM 2021), has documented a stark and growing disadvantage between the US and peer countries. US life expectancy stalled in 2011 and decreased thereafter, further widening the gap with peer countries. US health was therefore already in crisis when the COVID-19 pandemic began.

The enormous US death toll in 2020, the largest of any nation, produced a 23% increase in all-cause mortality, according to our latest *JAMA* study. Although the death toll fueled speculation that the decrease in US life expectancy during 2020 would exceed that of other countries, to our knowledge no study until ours has confirmed this. The disparity we report here is stunning. Striking this information from the paper, and reporting US results alone, without comparison to other countries as context, would withhold critical data and would prevent readers, particularly those in the US, from putting their country's experience in proper perspective. The need for this is salient; see the recent 4 May op-ed in *The Guardian* (https://www.theguardian.com/commentisfree/2021/may/04/why-do-americans-die-earlier-than-europeans).

That said, we do appreciate the editors' concerns about the heterogeneity of countries, which differ in so many ways (e.g., demography, economy), including their experience with COVID-19. The data bear out the editors' concerns, to a point. This bar chart presents our estimates of the net change in life expectancy for each country between 2018 and 2020. Not only did changes in life expectancy differ across peer countries, six countries saw an *increase* in life expectancy during this period. However, while the outcomes do differ greatly, the US (red bar) is a conspicuous outlier. Even in Spain, the peer country with the worst outcomes, life expectancy decreased by 1.09 years, far less than the decrease in the United States (1.87 years).



The range of results in peer countries, albeit large, comes nowhere near the US; no other country saw as calamitous a decrease in life expectancy. The editors raise an important concern, however, and we have therefore added an entire paragraph on this subject (page 9, lines 32-42). But we do not feel that the

heterogeneity is relevant in documenting the extraordinarily different experience of the US. We agree that differences between peer countries bear attention, and we have written a separate paper that "unpacks" the results for individual countries and discusses the potential influence of different policy approaches to pandemic control.

We certainly appreciate the editors' concerns that the United States is racially and ethnically diverse, with massive health disparities in historically marginalized groups, and that such diversity may not exist in other countries. Much for this reason, we stratify our results by race-ethnicity and show that *even white Americans* experienced a larger decrease in life expectancy than did peer countries, including Scandinavian countries that are overwhelmingly white. Ethnic diversity is difficult to compare across countries, but indices that have been developed suggest that more diverse nations than the US had better outcomes. The OECD Diversity Index for the US (2.8) is lower than that of Sweden (3.2), Switzerland (5.3), Austria (5.5), Israel (6.5)—but they all experienced a *smaller* decrease in life expectancy.

This is an important issue and we have therefore rephrased the text that compares decreases in US life expectancy among people of color with the average of peer countries, noting that the average is used as a benchmark for dramatizing racial disparities in the United States, not to suggest that the racial composition of peer countries is either uniform or comparable (see page 10, lines 16-26).

Table 1.2. **Diversity index based on country of birth, 2015**

Low		Moderately low		Moderately high		High	
POL	0.1	PRT	1.3	LVA	2.3	IRL	3.1
SVK	0.2	ITA	1.8	GBR	2.6	SWE	3.2
MEX	0.3	SVN	1.9	NOR	2.7	AUT	3.5
CHL	0.7	NLD	2.1	USA	2.8	CAN	4.5
CZE	0.7	DNK	2.1	EST	2.8	CHE	5.3
HUN	0.8	FRA	2.2	GER	2.8	AUS	5.5
GRC	1.2	ESP	2.2	BEL	2.9	ISR	6.5
FIN	1.2					LUX	7.1

From: OECD (2020), *All Hands In? Making Diversity Work for All*, OECD Publishing, Paris, https://doi.org/10.1787/efb14583-en.

The true meaning of life expectancy: It's a common misconception, but life expectancy for a given year does *not* refer to how long babies born that year are expected to live. A number of review comments, and an op-ed cited by the editors, seem to harbor that misconception. As most textbooks explain, life expectancy at birth is a summary statistic *for a specific year*, not for future years. It synthesizes the mortality conditions *of that year* by applying age-specific mortality rates to a hypothetical population. We recognize that misunderstandings about life expectancy are commonplace, and it was precisely for this reason that we inserted a text box at the beginning of the paper. We have revised the text box to further clarify the matter, which now reads as follows:

The meaning of life expectancy during a pandemic

Life expectancy is a widely used statistic for summarizing a population's mortality rates at a given time.[1] It reflects how long a group of people can expect to live were they to experience at each age the prevailing age-specific mortality rates of that year.[2] Life expectancy estimates are sometimes misunderstood. We cannot know what *future* age-specific mortality rates will be for people born or living today, but we do know the *current* rates. Computing life expectancy (at birth, or age 25, or age 65) based on those rates is valuable for understanding and comparing a country's mortality profile over time or across places at a given point in time. Estimates of life expectancy during the COVID-19 pandemic, such as those reported here, can help clarify which people or places were most affected, but they do not offer predictions of how long any group of people will live. This study estimates life expectancy for 2020. Determinations of life expectancy for 2021 and subsequent years—and how quickly life expectancy will rebound—cannot occur until data for those years become available. Although life expectancy is likely to recover in time to pre-pandemic levels, past pandemics have demonstrated that survivors can be left with lifelong consequences, depending on their age and other socio-economic circumstances.[3]

1. Riley JC. *Rising Life Expectancy: A Global History*. Cambridge, United Kingdom: Cambridge University Press; 2001.
2. Preston S, Heuveline P, Guillot M. *Demography: Measuring and Modeling Population Processes*. Oxford: Blackwell Publishers. 2001.
3. lmond D. Is the 1918 influenza pandemic over? Long-term effects of in utero influenza exposure in the post-1940 US population. *Journal of Political Economy*. 2006;114(4):672-712.

The editors may have overlooked this text box on the first submission, and in particular the callout to it at the beginning of the paper, because the page was placed at the end of the manuscript as is traditional for tables. To avoid confusion on this submission, we are abandoning traditional formatting by inserting it at the beginning (see page 4), in the approximate location it would appear for the reader.

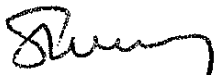
The importance of US policy and racism: We are uneasy about your request to remove statements about the role of US policy and systemic racism in explaining the large US death counts in 2020 and the deep racial inequities we report. The review comment suggested this was "conjecture." The public health consequences of choices made by the Trump administration and state governors have been widely documented in real time, and the history and transgenerational health impact of systemic racism on population and geographic health inequities have been studied for decades. Lest there be any question about the supporting evidence, we were careful to cite many references on both topics, many of which are review articles that themselves cite dozens of studies with empirical data.

This is a critical time in the United States, where social unrest sparked by the George Floyd murder has brought discussions of systemic racism into the open and called into question past practices of avoiding the term. President Biden has addressed systemic racism by name as a priority for his new administration, as have major US corporations, media organizations, and other institutions. The research community has joined in. The National Academies of Science, Engineering, and Medicine, along with other scientific societies, have issued bold calls for change. Medical journals have come under scrutiny. Although the *New England Journal of Medicine* was quick to address systemic racism (*N Engl J Med* 2021; 384:768-773) and a *Health Affairs* blog post called for bold reform (https://www.healthaffairs.org/do/10.1377/hblog20210219.107221/full/), the editor of *JAMA* was

recently placed on administrative leave because of a controversial podcast denying systemic racism. That incident and the larger controversy surrounding medical journals have attracted media coverage. *Time Magazine* covered a recent study in *Health Affairs* by Krieger et al., documenting the scarce references to systemic racism in most major medical journals (https://www.healthaffairs.org/do/10.1377/hblog20210415.305480/full/). A recent *Washington Post* article was entitled, "The health-care industry doesn't want to talk about this single word." In this environment we are uncomfortable not being explicit about systemic racism.

Please consider this background in reviewing our responses, which are detailed beginning on the next page.

Sincerely,



Steven H. Woolf, MD, MPH
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EDITORS

You categorise people from the US into 3 race-ethnicity categories, which perhaps does not represent how racially and ethnically diverse the population is.

We agree that the US population is very diverse and includes far more racial and ethnic groups than the three highlighted here, such as Asian/Pacific Islander, Indigenous, and other populations. However, we cannot derive life expectancy estimates for these groups because our calculations rely on official life tables produced by the National Center for Health Statistics. These are provided only for non-Hispanic Black, non-Hispanic white, and Hispanic male and female populations (e.g., see Arias et al. 2014 for 2010 [*Natl Vital Stat Rep*. 2014;63(7):1-63] and Arias et al. for 2018 [*Natl Vital Stat Rep*. 2020;69(12):1-45]). The Methods section now provides a clearer explanation for the exclusion of these groups (see page 6, lines 3-10).

On page 5, lines 48-51, we note that, between 2010 and 2019, the three racial/ethnic populations that we did study (non-Hispanic white, non-Hispanic Black, and Hispanic populations) accounted for 91-93% of the total US population. It is true that results for these three populations do not *fully* describe the degree to which differences vary by race/ethnicity (e.g., COVID-19-reated deaths among the Alaska Native/American Indian population are thought to be very high, perhaps the highest of any US population). However, because so much of the US population is included in our analysis, the life expectancy losses we report here are largely representative of the US experience.

We are sure there will be ramifications on life expectancy but isn't it rather soon to characterise this? And wouldn't we need a longer run in?

The notion that ramifications on life expectancy in future years make it too soon to calculate life expectancy for 2020 reflects the common misconception we discussed above. We cite a text box at the opening of our paper to make sure readers "are on the same page" about what life expectancy means and, on this revision, have inserted it prominently at the beginning. Life expectancy is not a prediction of mortality patterns in future years, only for the year(s) being analyzed. As Preston et al. (2001) state in their classic demography textbook, *Demography: Measuring and Modeling Population Processes*, life expectancy estimated from period life tables allows us to answer the question: "How should the period's 'mortality conditions' be operationalized?" (page 42). That is, how do we summarize the age-specific mortality rates experienced by a population in a given time period? In this paper, we are contrasting the 2020 "mortality conditions" for US populations with the average 2020 "mortality conditions" for populations in other high-income countries. What will happen to life expectancy in the coming years cannot be determined until data for those years become available—but that has no bearing on the validity of 2020 life expectancy estimates now.

Thank you for the excellent question about the need for a longer run-in. As noted earlier, that triggered an important change in the paper, notably the inclusion of fuller data in Figure 1, which strengthens our case.

In your limitations you state that 'race-ethnicity data for the U.S. population and for 2020 deaths were incomplete.' It would be interesting to know how incomplete it was.

That is an excellent point. As noted earlier, we now clarify in the Methods why the data were incomplete (see page 6, lines 3-8). Official US life tables are estimated only for the non-Hispanic white, non-Hispanic Black, and Hispanic populations. As we note on page 14, lines 10-13, empirical evidence suggests that 2020 mortality rates were likely substantially elevated for other US populations not reported here (e.g., American Indians and

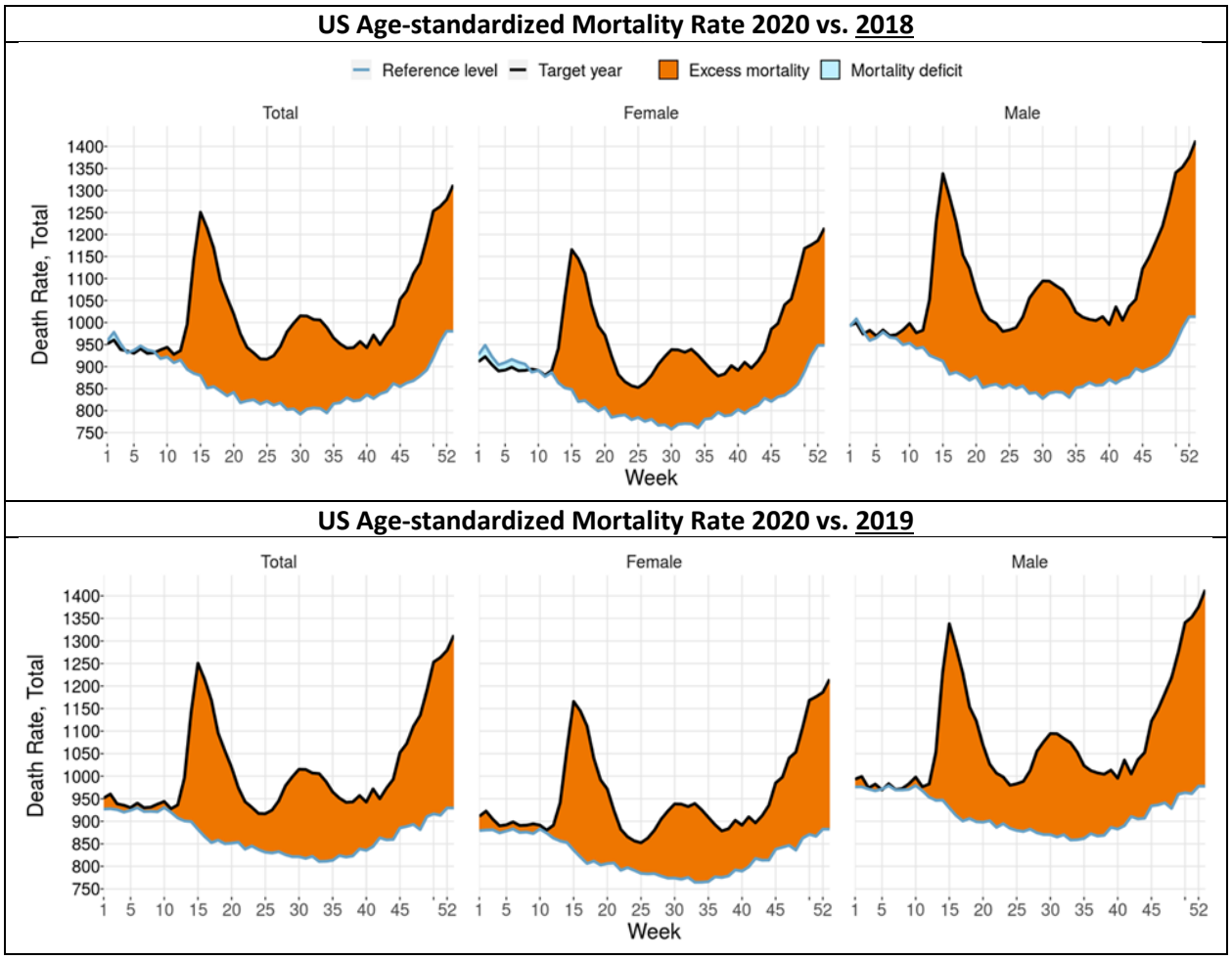
Alaskan Native). We also note, however, that our study analyzes more than 90% of the study population. As such, the limitations from the incomplete racial/ethnic data are minimal for our purposes.

The lack of 2019 comparison data is critical. Were there changes in life expectancy over the last decade? For instance did life expectancy decrease mid-decade in the US, then began to trend back up? Will this skew the results we are seeing? The editors think this underscores why the trend should be compared rather than a single data point (e.g., 2019 or 2015) or an average of the last few years (then the average will essentially be close to the LE estimate somewhere in 2015).

These are good questions; they inspired our redesign of Figure 1, where we now provide year-by-year data for the entire decade, with the exception of 2019. As to the omission of 2019, life tables for that year are lacking for US race/ethnic populations and a number of peer countries. We therefore could not both (1) include 2019 and (2) make meaningful cross-national comparisons—a priority for this project. The transparency of Figure 1 removes any questions about the degree to which our results are artefactual. The editors are correct that US life expectancy increased after 2017, but only slightly. According to the CDC, it increased by 0.1 year in 2018 (Xu et al. *NCHS Data Brief*, no 355. National Center for Health Statistics. 2020.) and (likely) again by 0.1 year in 2019 (Kochanek et al. *NCHS Data Brief*, no 395. National Center for Health Statistics. 2020.). These changes are trivial in comparison to the massive decrease in life expectancy we report for 2020 (1.87 years). The decrease in US life expectancy would only be slightly larger if we compared changes in life expectancy between 2020 and 2019 (approximately 1.97 years instead of 1.87 years), and this slight improvement would come at the cost of our comparison with peer countries. Further, age-specific mortality data for 2019 are not yet available for all US race/ethnic populations, and we therefore do not have the 2019 mortality records required for our 2020 life table estimates. In our revised analyses, we now use official US life tables from 2018 (Arias et al., 2020) instead of 2017, reflecting the most recent data available. The explanation for the absence of 2019 data now appears inn the abstract (page 2, lines 19-21), Methods (page 5, lines 37-44), and footnote of Figure 1.

Having established the year-to-year trend for the decade in Figure 1, our paper turns its focus to 2010, 2018, and 2020 for more detailed analysis. We continue to feel that these three time points are the best milestones for comparison. 2010, the beginning of the decade, marks a reference point, the culmination of a decades-long trend in which US life expectancy had been increasing more slowly than in other high-income countries, but increasing nonetheless. As Figure 1 shows, the US entered the decade with a 1.88-year gap with peer countries and—as US life expectancy plateaued and *decreased*—the gap widened steadily to 3.04 years by 2017. Because 2019 data are not available for many peer countries, we use 2018 as a reference point to show the enormous decreases in life expectancy brought about by the COVID-19 pandemic. The acute downward slopes in Figure 1 marking this decrease are more than adequate to dramatize the extraordinary fall in US life expectancy. Adding a data point for 2019 would not alter the primary conclusion.

To prove our point, below we assemble comparison data on age-standardized mortality rates by week for 2018 and 2019. The figures show that, while 2019 would be ideal to most accurately assess the change in life expectancy in 2020, the practical difference between 2018 vs. 2020 and 2019 vs 2020, is negligible (i.e., the orange areas representing elevated mortality rates in 2020 are comparable).



If the interest is in the impact of COVID-19 then isn't the interest in peak months as well as the year as a whole year? Further, is 2020 a complete picture of the impact of COVID-19? How does this study fit in that context? Would waiting until a later time provide a more complete picture?

This is an interesting point, but estimating month-over-month changes in COVID-19-related mortality complicates matters in a number of ways. First, period life expectancy is generally estimated, compared, and understood within a *year* time span. Second, how would we *understand* or make sense of life expectancy estimates during "peak months" of the pandemic, especially if the "peak months" differ by country? Moreover, to what time periods would we compare these life expectancy estimates to chart trends and/or to illustrate differences between populations?

Third, estimating life expectancy for COVID-related mortality during peak months understates the total impact of the pandemic and countries' varied responses to the pandemic. For example, limitations to travel and work during countries' lockdowns might reduce COVID-19-related mortality during non-"peak" months, but differentially impact mortality from non-COVID-19 causes (e.g., heart disease, diabetes) that other studies, including our own (*JAMA* 2021 Apr 2. doi: 10.1001/jama.2021.5199), have documented. Indeed, precisely because of the increase in non-COVID-19 deaths, all-cause mortality in the United States was elevated in 2020 even during months when COVID-19 rates were not surging. Again, note the orange areas in the above figure, showing that mortality rates were substantially elevated even during the off-peak months/weeks.

For these three reasons we maintain that 2020 period life expectancy is appropriate for estimating the *overall* toll of the pandemic on 2020 "mortality conditions" in each country's population(s).

To the question about waiting for a later time to get a "more complete picture," for reasons already explained life expectancy estimates for 2020 are in no way meant (or able) to capture the impact that COVID-19 will have at a later time. Life expectancy estimates focus on "mortality conditions" only for the year of analysis. It's fair to guess that life expectancy in 2021 will be higher than in 2020 but still lower than 2018 life expectancy and that the mortality effects of the pandemic will play out well into the future. That said, we need not wait for those years to pass before beginning to document the effects on life expectancy in 2020. When the data become available, life expectancy for 2021 should be calculated separately from life expectancy for 2020, and differences in these life expectancies will be informative for understanding how distinct features of 2021 (e.g., unequal effects of new variants for countries and populations, different vaccination rollouts) differentially affect populations' "mortality conditions" in that year.

For many reasons we think the comparison to peer countries is not optimal. We don't think the peer countries are necessarily comparable and averaging over multiple countries is problematic, in our minds. This is particularly because the race/ethnicity data is not comparable between the US and other countries. To move forward we would want that replaced and have several suggestions we hope the authors will consider.

See above. Not comparing the US with peer countries is quite problematic, given the goals of this project. There is an important and growing literature on cross-national comparisons that began 15 years ago in Europe and has expanded over time. None of these cross-national studies contends that all countries in their analysis are homogenous. Population demographics are never identical, but valuable insights are gained by understanding the mechanisms, particularly policy approaches, that may help explain differentials. As exemplified by the Global Burden of Disease studies published over the years in *Lancet*, there is great value in contrasting the disease burden of countries, even while acknowledging that their demographic composition, economies, and other factors differ.

This genre of work is especially important for the United States, which is an outlier in many cross-national comparisons—and is again here. This article adds an important update to that literature. The most recent publications comparing life expectancy in the US and peer countries cut off at 2017. Our paper not only carries the literature forward to 2018 but includes the first published evidence of what happened in 2020 and how dramatically that year magnified the cross-national gap. The US zeitgeist of "American exceptionalism" fosters denial among politicians and the public, making it even more important for the research community to raise awareness about the facts. The US public can easily delude itself into believing that setbacks in life expectancy that it experienced during the pandemic were not unlike those of other countries. If no studies are published to refute this idea, the country can turn a blind eye to the disproportionate loss of life the US experienced. Our analysis, to our knowledge, is the first study to put out the facts and the stunning nature of those facts make it a blockbuster finding.

The editors raise a fair question about the potential problems with *taking the average* of peer countries, but we think this is defensible. The earlier bar graph displayed the individual-level variance in detail, which we have analyzed at an individual country level in another paper. We hope the editors are persuaded by the earlier figure that the peer country experience, despite its variance, is clearly distinct from that of the US. Even the worst performer (Spain) did not come close to the US. The peer average is perfectly suitable for making this point, but in deference to this issue we have added a new paragraph on this topic (page 9, lines 32-42), in which we discuss the variance and report outcomes for some individual countries.

Finally, we understand that comparisons between the life expectancy of Black and Latinx populations in the US to the average outcome of peer countries produces some asymmetry, because they are not being compared to the corresponding marginalized racial/ethnic populations within those countries. But that is not our goal, which would of course require a complex cultural analysis across peer countries to make appropriate selections of comparable ethnic groups. Such an analysis would face its own criticism for ignoring differences in history and context, such as the 400-year exposure to slavery that is unique to the US and some other former colonial powers. The OECD Disparity Index is an attempt at making such comparisons, but to our knowledge no metric has yet been widely accepted for racial/ethnic comparisons across countries. Instead, our focus is on showcasing the size of racial/ethnic disparities in the US. For this purpose, we are only using the peer country average as a *benchmark* for comparison. Underscoring the gravity of this disparity is a priority, particularly in this moment in the United States, when increasing attention is focused on confronting the magnitude of those racial disparities.

That said, the editors' concerns about racial diversity in the US are important and we have therefore stratified the data in Figure 1 by race/ethnicity. This allows the reader to see that, even without considering results for US people of color, the loss of US life expectancy in the white population is still distinctly greater than losses in peer countries. The line for US whites in Figure 1 doesn't even overlap the range of error for peer countries, depicted as a gray band surrounding the peer country average. Figure 1 of course also dramatizes the much larger decrease in life expectancy among Hispanic and non-Hispanic Black populations.

1) Change the focus on just the United States, and examine the disparities deeper by race/ethnicity and sex in the context of historical trends within the US.

We don't know what you mean by examining disparities "deeper by race/ethnicity and sex" or "in the context of historical trends." This would be an entirely different paper, and these types of analyses already exist (e.g., Levine et al. *Public Health Reports*. 2001;116(5):474-483; Harper et al. *JAMA*. 2007;297(11):1224–1232; Satcher et al. *Health Aff*. 2005 Mar-Apr;24(2):459-64; Woolf et al. *Am J Public Health*. 2008;98(9 Suppl):S26-8; Ho and Elo. *Demography* 2013;50:545–568; Masters et al. *Demography* 2014;51:2047–2073). Most recently, see Chapter 1 in *High and Rising Mortality Rates Among Working-Age Adults* (Washington, DC: The National Academies Press, 2021), produced by one of us (RKM). If the comment refers to the above idea of reporting data for other racial groups, such as Asian or Indigenous peoples, please see earlier explanation about the lack of official life tables for those groups.

2) Add more data from the US. The Life Table, disaggregated by race/ethnicity, which is available from the CDC since 2011 and at least up to 2017.

Thanks for this suggestion. We have added data for intervening years, citing the CDC life tables for all intervening years, and changed Figure 1 from a bar chart to a line graph so that readers can see the year-by-year trend from 2010 through 2020 (excepting 2019) and the sudden drop in 2020. We appreciate the suggestion, because it more powerfully demonstrates the steadily widening gap in life expectancy between the US and peer countries that preceded the pandemic, how the extraordinary decrease in life expectancy in 2020 widened this gap even further, and the massive disparity in trends by race-ethnicity.

3) Add at least the additional race of Asian/Pacific Islander, and please reconsider how you operationalized race and ethnicity--it is possible to be both Black and Hispanic, for instance, but that doesn't seem to be covered here.

Again, for reasons explained above, we cannot add official life expectancy estimates for Asian/Pacific Islanders.

As to the other point, we of course understand that people can be Hispanic and Black. The classic OMB definition used in the US literature typically handles this in a matrix approach that divides the population by ethnicity into "Hispanic" and "non-Hispanic" categories and classifies each category by 5 racial groups. Conventional papers (and our figures and tables) refer to "non-Hispanic Blacks," "non-Hispanic whites," etc. However, many scholars are moving away from the dated OMB definition of racial-ethnic groups out of respect for the different ways people prefer to identify their race or ethnicity. See, for example, "The Reporting of Race and Ethnicity in Medical and Science Journals" (*JAMA*. 2021;325(11):1049-1052). Scholars have urged authors to change Methods sections to either embrace the terminology subjects prefer to self-designate their ethnicity or provide a justification for not doing so. A recent style guide provided the wording we used:

> "Although many U.S. individuals self-identify as Latino or Latina, this study uses "Hispanic" to maintain consistency with data sources. '*White' and 'Black' hereafter refer to those who do not identify as Hispanic or Latinx*." (italics added)

In this usage, "White" refers to NH white, "Black" refers to NH Black, etc. Our methods section is unambiguous that we are examining data for three mutually exclusive groups: the Hispanic, non-Hispanic Black, and non-Hispanic white populations. We are trying to follow the guidance of scholars to approach this topic differently, but will defer to the editors if they fell it will avoid confusion to insert "non-Hispanic," or its abbreviation "NH," before every use of race in the text.

4) Add additional life tables for years 2018 & 2019, which could be estimated (the way you estimated for the year 2020) from the mortality data available at, for example, CDC Wonder. This way, the analysis will cover the trend for the last decade, and the results for 2020 would be better put into context.

As noted earlier, we followed the editors' advice and added data for 2011-2016 and 2018 but, for reasons detailed above, could not include 2019.

5) Consider presenting the age-and-sex-specific Covid-19 mortality by race/ethnicity to provide additional insights on the effect of that on the estimated changes in LE.

We do not understand this suggestion. Whether for all-cause mortality or cause-specific (e.g., COVID-19) mortality, we don't see how stratifying age-specific mortality rates by race/ethnicity and sex (which is widely available) would be more informative than presenting differences by life expectancy, which are not available.

To repeat, life expectancy summarizes the impact of all age-specific mortality rates for a population in a given year. To revert back to reporting age-specific mortality rates would preclude useful comparisons of the total mortality impact of the pandemic on these populations. Researchers use the summary measure because (1) it is so informative (i.e., a global measure of the total mortality impact), (2) accounts for age differences (i.e., as opposed to deaths per capita) and (3) simplifies comparisons of "mortality conditions" across geographies.

As a practical matter, there would simply be inadequate space to report, present, and discuss racial/ethnic and sex differences in age-specific death rates at ages 25-29, 30-35, …, 80-84, 85+ and differences in countries' death rates at ages 25-29, 30-35, …, 80-84, 85+. Comparing outcomes in this unwieldy fashion would be very difficult for readers to digest. This is among the reasons researchers use life expectancy as a summary statistic.

6) Perform analyses for overall estimates and compare those to stratified results in the paper

The paper already did this. In this revision, life expectancy in 2010, 2018, and 2020 is reported for the total US population and the US male and female populations, in each case stratified by race/ethnicity, and this is done for life expectancy at birth, age 25, and age 65.

7) As a validity check, please compare the LE estimates from your simulation model to those reported by the CDC Life Tables (from .

This is a great suggestion. We performed these sensitivity analyses soon after Arias et al. published their 2021 study (Arias et al. Provisional life expectancy estimates for January through June, 2020. Vital Statistics Rapid Release; no 10. Hyattsville, MD: National Center for Health Statistics. February 2021).

We estimated life expectancy among US male and female non-Hispanic Black, non-Hispanic White, and Hispanic populations using data from the January 7 data release of the CDC's *AH Excess Deaths by Sex, Age, and Race* file (https://catalog.data.gov/da_DK/dataset/ah-excess-deaths-by-sex-age-and-race-2d26a). We summed the counts of death occurring between weeks 1 and 28 to match the January-June timeframe analyzed by Arias et al., and then merged these death counts with U.S. population estimates for the first half of 2020. Here, we provide comparisons of our estimates of life expectancy at birth for US non-Hispanic Black, non-Hispanic White, and Hispanic male and female populations with respective estimates reported by Arias et al. (NS in the table indicates "non-significant" differences in our estimates and those reported by Arias et al.).

Life Expectancy at Birth, First Half 2020

	Arias		Estimate	
Female Populations				
US NH Black	75.80	75.99	(75.63; 76.36)	NS
US Hispanic	83.30	82.53	(82.23; 82.84)	
US NH White	80.60	80.39	(80.08; 80.71)	NS
Male Populations				
US NH Black	68.30	68.70	(68.29; 69.12)	NS
US Hispanic	76.60	75.94	(76.58; 76.31)	
US NH White	75.50	75.28	(74.92; 75.65)	NS

We should note that that Arias et al. used death reports through October 2020, and we used early reports of weekly death counts in 2020 (i.e., January 7 data release) to maximize comparability. However, the time lag between our data and the October 2020 data might have increased counts of death in our data. Further, Arias et al. report substantial urban-rural differences in reporting deaths during the first half of 2020, possibly undercounting deaths in rural Latinx populations. This is a likely source of the discrepancies in our estimates. Overall, our estimates of life expectancies derived from death counts during the first half of 2020 match very closely those reported by Arias et al., despite the difference in data and analytical approaches. We believe that the official estimates of U.S. life expectancies reported by the CDC will fall within the P_5 and P_{95} estimates reported in our manuscript.

The reviewer's suggestion to validate our life expectancy estimates of U.S. populations prompted us to consider validating our estimates for other countries too. Specifically, Arbuto et al. (2021) estimated male and female life

expectancy at birth in England (http://dx.doi.org/10.1136/jech-2020-215505). Below, we provide our estimates of 2020 male and female life expectancy in England/Wales and contrast them with estimates by Aburto et al. We also provide the 2019 life expectancies reported by Arbuto et al. to show the estimated changes in England/Wales life expectancies between 2019 and 2020.

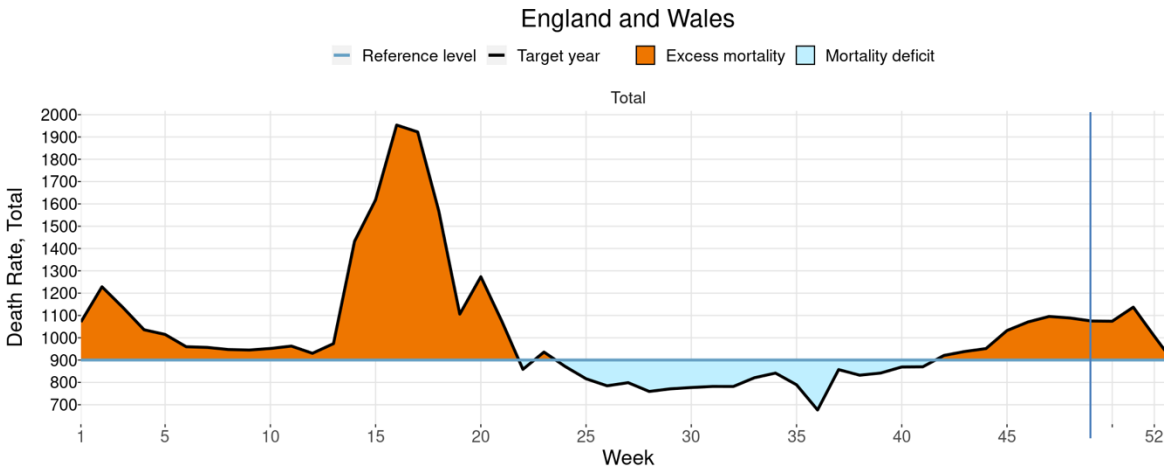
Life Expectancy at Birth in England & Wales by Sex, 2019 & 2020

	2019	2020	LB	UB	19 vs. 20	LB	UB
England & Wales							
Female	83.60	82.50	82.35	82.66	-1.10	-1.19	-0.89
Female, Oxford	83.60	82.60	82.50	82.60	-1.00	-1.10	-1.00
Male	79.90	78.43	78.28	78.59	-1.47	-1.56	-1.25
Male, Oxford	79.90	78.70	78.60	78.70	-1.20	-1.30	-1.20

Oxford Estimates: http://dx.doi.org/10.1136/jech-2020-215505

Note: Oxford Estimates from week 10 through week 47 of 2020

We find no significant differences between our estimates of 2020 England/Wales life expectancies and those reported by Aburto et al. The ranges between the lower bound and upper bound estimates overlap, although our point estimates suggest that 2020 life expectancies in England/Wales were a bit lower than estimated by Aburto et al. One explanation is that our estimates are derived from all weeks in 2020, whereas Aburto et al. relied on data through week 47 only. Deaths from COVID-19 in England/Wales were relatively high during the final weeks of 2020, and the contributions of these deaths to 2020 life expectancy are not reflected in Arbuto et al. See, for example, the estimated total death rate of England/Wales in 2020 vs. 2019 across all 52 weeks from the HMD-SMTF (the blue vertical line indicates ~47 weeks):



Please address this criticism made of the CDC estimates previously:
https://www.statnews.com/2021/02/25/cdc-one-year-decline-life-expectancy-really-five-days/

The reference is to an op-ed, not a scholarly paper, posted online by Peter Bach, a pulmonologist at Memorial Sloan-Kettering and a friend to one of us (SHW). Peter says that "My own estimate is that when Covid-19's ravages in 2020 are averaged across the country's entire population, we each lost about five days of life." His back-of-the envelope calculation is peculiar and not at all an estimate of life expectancy loss: he multiplied

400,000 deaths by 12 years (because “Covid-19 robs its victim of around 12 years of life”), and divided this by a population of 330 million. No citation supports this as a method for calculating life expectancy, and this method produces an erroneous estimate of changes in life expectancy. In criticizing what he calls a flawed assumption by the CDC, Peter embraces the misconception discussed earlier. His definition of life expectancy at birth is, “that for the year you are studying (2019 compared to 2020 in this case) the risk of death, in every age group, will stay as it was in that year for everyone born during it.” No one, including us, believes that mortality rates will never change. Again, life expectancy describes mortality rates *for the year being analyzed* by applying that year’s age-specific mortality rates to a hypothetical population cohort. As shown in the example below, the life expectancy estimates reported for 1990 were not a prediction of 1991, 1992, or any other year; the estimates for each year describe conditions only *for the year of analysis*. Any experienced demographer will back us up on this basic principle. We purposely inserted a text box at the beginning of the paper to address this common source of confusion among readers.

Table 12. Estimated life expectancy at birth in years, by race and sex: Death-registration States, 1900–28, and United States, 1929–2002

[For selected years, life table values shown are estimates; see “Technical Notes.” Beginning 1970 excludes deaths of nonresidents of the United States; see “Technical Notes”]

Area and year	All races			White			Black[2]		
	Both sexes	Male	Female	Both sexes	Male	Female	Both sexes	Male	Female
United States[1]									
2002	77.3	74.5	79.9	77.7	75.1	80.3	72.3	68.8	75.6
2001	77.2	74.4	79.8	77.7	75.0	80.2	72.2	68.6	75.5
2000	77.0	74.3	79.7	77.6	74.9	80.1	71.9	68.3	75.2
1999	76.7	73.9	79.4	77.3	74.6	79.9	71.4	67.8	74.7
1998	76.7	73.8	79.5	77.3	74.5	80.0	71.3	67.6	74.8
1997	76.5	73.6	79.4	77.2	74.3	79.9	71.1	67.2	74.7
1996	76.1	73.1	79.1	76.8	73.9	79.7	70.2	66.1	74.2
1995	75.8	72.5	78.9	76.5	73.4	79.6	69.6	65.2	73.9
1994	75.7	72.4	79.0	76.5	73.3	79.6	69.5	64.9	73.9
1993	75.5	72.2	78.8	76.3	73.1	79.5	69.2	64.6	73.7
1992	75.8	72.3	79.1	76.5	73.2	79.8	69.6	65.0	73.9
1991	75.5	72.0	78.9	76.3	72.9	79.6	69.3	64.6	73.8
1990	75.4	71.8	78.8	76.1	72.7	79.4	69.1	64.5	73.6

Please take out statements in the paper such as ...."are products of policy choices and systemic racism." This is not necessarily data driven an is conjecture.

As noted above, we respectfully disagree. First, with respect to policy choices, both empirical research (including our own work and references 49-54) and the tracking projects cited in our paper (references 55-58) have demonstrated the causal influence of national and state policies on the high US mortality rate, the timing of surges, and the distinct differences in epidemic curves across the 50 states. The history of systemic racism is hardly “conjecture.” We devote a full paragraph to discussing the evidence and cite seven references (references 64-70) that review this evidence in detail. Both claims are “data-driven.”

For us, the problem is not the reference to systemic racism in the abstract but the failure to do so in the text, which we have remedied (see page 13, line 8). Perhaps this inconsistency—that the term used in the abstract did not appear in the text—is what bothered the editors. We now do refer to systemic racism by name and continue to cite the supporting research.

Please change your title so that it addresses what was done, but not necessarily advertising the results. For instance, using "changes" instead of "declines."

Good suggestion. We changed the title.

REVIEWER 1

Major Comments

Methods: You may want to clarify how Hispanic, White, and Black were operationalized. For example, was it possible for persons to identify as Hispanic and White/Black given that race and ethnicity are not the same? This should be better specified because these groups should be mutually exclusive.

Our explanation for calculating life expectancy for U.S. race/ethnic populations is stated in the paper, and is discussed above.. The reviewer might have been less confused if we used the 5 OMB categories (Hispanic, NH white, NH Black, NH API, NH AIAN), but as noted earlier the literature is coming to grips with the need to speak about race and ethnicity in ways that respect how members of these groups identify themselves. As stated earlier, we can insert "NH" if the editors prefer.

Methods: This reviewer is confused about why direct sources for Israel and New Zealand were used to abridge 5-year lifetables for the male and female population of the peer countries when these countries were already included in the Human Mortality Database.

We apologize for any confusion. The explanation is quite straightforward. Although the HMD does provide five-year abridged life tables and single-year life tables for Israel and New Zealand, they were not available for recent years. Specifically, the HMD provided data for Israel only for years 1983-2016 (https://www.mortality.org/cgi-bin/hmd/country.php?level=1&cntr=ISR) and for New Zealand for years 1948-2013 (https://www.mortality.org/cgi-bin/hmd/country.php?level=1&cntr=NZL_NP). On page 6, lines 48-51 we now provide greater clarity about why the direct sources were used.

Methods: It might be worth explaining why the age groups for weekly death counts by country differ from age-specific death rates.

We have made this clearer in the supplementary materials. The life table estimates are derived from data reported by five-year age groups. The mortality rate estimates in STMF are derived from data reported by varying age groups: 0-14; 15-64; 65-74; 75-84; 85+. The difference between them is not problematic, so long as the age groups used in the STMF adequately represent the age patterns of mortality rate ratios between 2020 and 2018. This is akin to a piecewise exponential discrete-time hazard model that estimates mortality rates in 2020 vs. mortality rates in 2018, assuming that mortality rates are elevated constantly across these age groups.

While the authors have acknowledged the limitations of their study, it could be challenging to make bolder conclusions with these data because they were simulated (2020 life expectancies) and acquired from various sources. Thus, this reviewer is concerned the results are premature.

Concerns about prematurity are valid, but we doubt the estimates are significantly biased. The results we reported in the original submission were the fifth set of estimates we had produced, and this revision includes a sixth update. With each update we see smaller and smaller changes, which makes us increasingly confident in the precision of our estimates. We do regular updates because death counts for 2020 are periodically updated

by the CDC and HMD as new data trickle in. The updates have not significantly affected our estimates of 2020 life expectancy and fall well within the 5th and 95th percentile of estimates from our simulated life tables. We are confident that the final 2020 LE estimates reported by the CDC in the coming years will fall within our estimated range.

Technically speaking, we are not "simulating" life expectancy (the reviewer's term), we are simulating *estimates* of 2020 life expectancy to address the reviewer's very concern: due to preliminary data and the multiple sources used to estimate life expectancy, we bound our estimates with uncertainty (10%) and then provide a range of estimates (i.e., we report the 5th, 50th, and 95th percentiles of the life expectancy estimates). This is a common approach in demography.

There are three additional reasons to believe that our estimates are not "premature":

1) Both the CDC and HMD report that data inaccuracies are concentrated in the *most recently* reported death counts (i.e., the past three to five weeks). We are analyzing data for weeks 1-53 in 2020, which have now been updated for several months. This paper uses data updated on April 14, 2021. Any remaining underreporting or inaccuracies are likely minimal.
2) Our life expectancy estimates are consistent with the CDC's own preliminary estimates for the first half of 2020 (see above comparison of life expectancy estimates with those reported by Arias et al., 2021).
3) As a validity check, our life expectancy estimates for England/Wales are consistent with other life expectancy estimates for England/Wales, such as Arbuto et al., 2021 (https://www.medrxiv.org/content/10.1101/2021.03.02.21252772v1)

Table 1: Interestingly, in 2020 total life expectancy at birth was about 76.9 years. Likewise, total life expectancy at age 25 was about 52.9 years (25.0 + 52.9 = 77.7 years (about the same as at birth)). However, total life expectancy at age 65 is about 18.3 years (65.0 + 18.3 = 83.3 years), which seems to drastically exceed the life expectancy at birth. Why might this be the case?

This question, which every demography or epidemiology student should know how to answer, suggests that the reviewer has limited experience in this topic area. The short answer is that life expectancy at age 65 is conditional on surviving to age 65 and excludes those who would have died at earlier ages. Specifically, life expectancy at age 65 is estimated as the total years of life expected to be lived beyond age 65 (T_{65}) by *those who have survived* to age 65 (l_{65}).

While this research question is interesting in concept, it might be challenging for us at this time to factor in how COVID-19 will longitudinally influence life expectancy given that COVID-19 deaths in 2020 and 2021 may overall inflate COVID-19 deaths on a longer-term COVID-19 timeline.

COVID-19 will certainly affect us for some time but, again, the reviewer's question reflects a misunderstanding of life expectancy. This paper is not about "how COVID-19 will longitudinally influence life expectancy." It is an estimate of mortality only for the years of analysis, and makes no projections about how life expectancy will rebound in years to come.

Minor Comments

Introduction: "That the United States…" reads awkward. Consider revision.

Agreed. We modified the sentence (see page 4, lines 10-17).

Introduction: Consider revising "People of color…" to "Certain races, ethnicities, and age groups…" or similar. This comment may generalize to other locations in the manuscript.

We made this change (page 5, line 15).

Introduction: "affected life expectancy" could be "affects" because the sentence implies non-past tense language.

Agreed. We changed it to "is affecting" (page 5, line 17).

Methods: "However, observed changes in life expectancy between 2017 and 2020 were largely attributable to the events of 2020" Consider adding a supporting citation or tone down language a little.

We removed the statement from the abstract but stand by its accuracy and retain it in the text, now using 2018 as the reference year. US life expectancy changed 0.1 year from 2017 to 2018, and preliminary reports suggest that it increased 0.1 year between 2018 and 2019 (Kochanek et al. Mortality in the United States, 2019. NCHS Data Brief, no 395. Hyattsville, MD: National Center for Health Statistics. 2020.). The 1.87-year decline we report between 2018 and 2020 is clearly the result of the events of 2020. We do not consider a citation necessary to assert that a global pandemic occurred that year.

Results: Adding relevant confidence intervals where appropriate in the text would help for providing the necessary details regarding differences.

As explained in the Methods, we do not use confidence intervals, but we did include error simulations in the tables. We defer to the editors on whether they want the 5^{th} and 95^{th} percentiles inserted in the text.

Figures: While this provides a nice data visualization for the findings, some of the information repeats what is already provided in the tables in a relatively non-unique fashion (i.e., bar chart).

Figure 1 has been revised, from a bar chart to a very uniquely designed line graph, and adds new information not elsewhere in the paper. We believe Figures 2-3 provide a vivid depiction of the massive disparities we report and are likely to be widely reproduced. They plot only a subset of the information in the data tables and do not strike us as repetitive.

Tables: The decision to present confidence intervals for 2020, and 2020 vs. 2017 seems incomplete. Consider revising to include consistent information.

Presumably the reviewer is reacting to the lack of error estimates for 2010 and 2017 (now 2018), but those did not require simulations to calculate. They are reports of U.S. life expectancies made available in official life tables. Error estimates only make sense for 2020 (and the columns reporting the difference between the 2020 estimates and prior years), as this is the only situation in which life expectancy is being modeled.

Abstract: Make any relevant changes to the abstract that align with those from the main text.

Done.