NOTICE: This document contains correspondence generated during peer review and subsequent revisions but before transmittal to production for composition and copyediting:

- Comments from the reviewers and editors (email to author requesting revisions)
- Response from the author (cover letter submitted with revised manuscript)*

*The corresponding author has opted to make this information publicly available.

Personal or nonessential information may be redacted at the editor’s discretion.

Questions about these materials may be directed to the Obstetrics & Gynecology editorial office: obgyn@greenjournal.org.
RE: Manuscript Number ONG-23-353

The Role of Maternal Age in Increasing Severe Maternal Morbidity Rates in the US

Dear Dr. Berger:

Thank you for sending us your work for consideration for publication in Obstetrics & Gynecology. Your manuscript has been reviewed by the Editorial Board and by special expert referees. The Editors would like to invite you to submit a revised version for further consideration.

If you wish to revise your manuscript, please read the following comments submitted by the reviewers and Editors. Each point raised requires a response, by either revising your manuscript or making a clear argument as to why no revision is needed in the cover letter.

To facilitate our review, we prefer that the cover letter you submit with your revised manuscript include each reviewer and Editor comment below, followed by your response. That is, a point-by-point response is required to each of the EDITOR COMMENTS (if applicable), REVIEWER COMMENTS, and STATISTICAL EDITOR COMMENTS (if applicable) below.

The revised manuscript should indicate the position of all changes made. Please use the "track changes" feature in your document (do not use strikethrough or underline formatting).

Your submission will be maintained in active status for 21 days from the date of this letter. If we have not heard from you by 03/30/2023, we will assume you wish to withdraw the manuscript from further consideration.

EDITOR COMMENTS:

Please note the following:

1. Please make sure to address Reviewer # 4 (statistical editor) point regarding Table 2.

2. Lines 23 to 26. The authors should revise this to state their primary finding. That is that increases in the SMM rates was due to increases in age-specific rates.

3. Lines 234 to 244. Some other limitations that may need to be pointed out. I am assuming that the NIS dataset analyzed was for inpatient admissions with delivery. This does not reflect SMM rates that may have occurred with a postpartum readmission or up to one year postpartum. Further, understanding the conclusion could be that pre-pregnancy health status may be worsening, no adjustment for comorbidities was undertaken between the two time periods.

4. Line 241 (minor point). Did you mean for this to the "third" point and not the "fourth?"

* Help us reduce the number of queries we add to your manuscript after it is revised by reading the Revision Checklist at https://journals.lww.com/greenjournal/Documents/RevisionChecklist_Authors.pdf and making the applicable edits to your manuscript.

* Figures 1-2: Please upload as individual figure files on Editorial Manager.

REVIEWER COMMENTS:

Reviewer #1:

Introduction
The expectation for the analysis is that the changing profile in maternal age isn't going to be a major determinate of SMM because increases in maternal age over the study period haven't been that dramatic.

Methods
Why not compare trends continuously from 2008 to 2018? Data from 2020 is out. Why not analyze 2008 to 2020? It's been a while since 2018 was the most recent iteration (>2 years).

(Ah OK I see later on that you analyze 2008-2018. This is confusing. It would be better to say earlier on that you have access to that sample and then are making a specific comparison between the beginning and end of the study period.)

Why do you combine years e.g. 2008 and 2009? The NIS is a sample that creates national estimates. You could just compare 2008 to 2018.

Line 62-64 The info on the 'primary sample' is confusing, because you say you will apply weights but those aren't the weighted estimates.

Line 87-88 'Except for yearly trends in SMM rates between 2008-2018, SMM rates at two time points (2008-2009 and 2017-2018) were pooled over 2-year periods to obtain stable estimates.' Large sample with common outcome - you shouldn't need to pool to get stable estimates.

Line 89-90 'Maternal age groups were assessed as: <20, 20-24, 25-29, 30-34, 35-39, 40-44, and 45+90 years' Risk goes up with age <18 - not sure why 18 and 19 year olds were included in this category.

Results
You only have 3 million+ estimated deliveries total? I don't think you applied weights correctly. For 4 year period you should have 14-16 million delivery hospitalizations.

AMA deliveries only increased 2.3% which is intuitive and what would be expected from the natality statistics.

Line 155-159 - you should probably include some risk estimates here.

Discussion
The immediate question is to what degree age effects are a proxy for increased risk for a number of comorbid conditions in this population. Is the driver of increasing morbidity underlying comorbid risk? There are a number of ways this could have been analyzed within this study. You could run regression models for SMM stratified by age group accounting for underlying comorbidity to estimate effects of year within each age category.

Overall the stratification of trends and outcomes by race doesn't make too much sense to me. What was the specific purpose of disaggregating by race? We already know there are differentials in risk by race by age group with older black women at highest risk.

Reviewer #2:
Obstetrics and Gynecology
Manuscript #ONG-23-353

"The role of maternal age in increasing severe maternal morbidity rates in the US"

GENERAL
This study reviews the NIH inpatient database for severe maternal morbidity variables at two separate intervals to isolate the contributory effect of maternal age on rates.

1. The manuscript is extremely articulate and well-organized.
2. Does the source data permit determination of multiple deliveries to the same individual?

3. Given the discussion regarding transfusion and non-transfusion severe maternal morbidity (SMM) rates (Lines 78-87), do the authors feel overall SMM rates represent a valid measure? (or perhaps only the relative change in SMM)?

4. What does the phrase "growing structural inequality across the life course" mean? Consider rephrasing in more conventional terminology.

5. Does the source data permit distinguishing singleton from multiple gestations? If so, the (possible) incremental increase of multiple over singleton pregnancies at the specific age ranges would be of additive value for counseling.

6. Consider commenting in the Discussion what the authors would consider to represent a significant change in SMM rates (i.e., Line 217 - would <2% range represent a clinically significant difference?).

7. Consider including columns in Table 1 highlighting the differences in each variable between the two-time intervals.

Reviewer #3: The authors have carried out a US population based study using data from the National Inpatient Sample to evaluate the impact of changes in maternal age over time on SMM. It is generally thought that the increase in SMM is driven primarily by the change in maternal age distribution over time. The authors compare two cohorts (from 2008-2009 with 2017-2018). The results are interesting, showing that apart from certain racial groups, the increase in older maternal age was not the primary driver of increasing SMM rates in the United States.

The study is very well-designed, and the manuscript is well written. It is easy to understand and straightforward. The length is appropriate, and not too long.

The tables and figures are well laid out.

The major change due to maternal age in SMM was amongst Blacks where maternal age accounted for 17% of the changing SMM and 34% of the change in non-transfusion SMM. This is interesting.

Perhaps the most intriguing finding is of the dramatic increase in SMM rates occurring among people identified as AI/AN (line 162-164). Can the authors explain this? While this was not the primary objective of this study, it certainly is important and of interest?

Similarly, why do the authors think that the increase in transfusion rates was so high for people under 20 years old? (Line 189-190). Again, not the primary focus, but perhaps a line addressing these 2 important findings may be helpful.

In line 181 to 182, did the authors intend to put a slash between "Hispanic people" and "those of other race"?

Overall, a well designed and written study that may help us understand change in maternal SMM in relation to age and may provide some insight that may help direct potential interventions.

STATISTICAL EDITOR COMMENTS:

lines 47-49 and 87-88: Should clarify in lines 47-49 that each time period was inclusive, i.e., two full years, so that the total deliveries in subsequent tables were consistent with ~ 20% of total US deliveries during a two-year period.

Table 1: Should note that the "UR" unreported race is the 3rd largest cohort among 7 in 2008-2009, larger than reported Black, Asian, AI/AN, yet became the 6th out of 7 in 2017-2018. In the first time period, UR comprised ~ 17% vs ~ 4% in the two time periods. Thus, comparisons by race, especially for the smaller groups, are subject to selection bias and imprecision. Were there any other categories of missing data for race/ethnicity? Also, the group AI/AN especially and to a lesser extent, the groups Asian/PI or Other/Multi have relatively fewer deliveries and thus fewer deliveries in the various age strata. Thus, estimates of SMM have more imprecision and are more difficult to sequentially compare. Should indicate in Table where there are statistically significant differences between time periods, but should employ a stricter inference threshold than < 0.05, owing to the multitude of comparisons and thus multiple hypotheses being tested.

Table 2: It should be noted that among the RRs that are significantly different from the null, several of the differences are numerical, not statistical differences between pairs of RRs (or of ratios of RR). For SMM, the RRs for White, Black and Hispanic are statistically indistinguishable, while all three are statistically significantly different from AI/AN and Asian, while the latter two are indistinguishable from each other. For Non-transfusion SMM, now White is NS, Black and Hispanic are
indistinguishable from each other, as are AI/AN and Asian, while the members of each like pair are statistically significantly different from each member of the other like pair. Should also include CIs for the 4 columns following RRs and indicate which show statistically significant changes over the time periods in question.

Table 3 could probably be in supplemental material.

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Sincerely,
Mark A. Turrentine, MD
Consultant Editor

The Editors of Obstetrics & Gynecology

In compliance with data protection regulations, you may request that we remove your personal registration details at any time. (Use the following URL: https://www.editorialmanager.com/ong/login.asp?a=r). Please contact the publication office if you have any questions.
RESPONSE TO REVIEWERS
April 13, 2023

We thank the Editors and Reviewers for their review of this manuscript, and we thank the editors for the opportunity to submit a revision. We greatly appreciate the constructive reviews and feedback, and we believe the revised manuscript is stronger as a result. Below, we respond to each comment in detail.

EDITOR COMMENTS:

Please note the following:

1. Please make sure to address Reviewer # 4 (statistical editor) point regarding Table 2.
   
   **Author’s Response:** We have responded to the three points in the Statistical Editor’s comment regarding Table 2. However, we would like to clarify one of the points raised in the comment. We will repeat the question posed below to the Statistical Editor:
   
   We would like to clarify the ask from the Statistical Editor on this point: is this comment requesting that we note in the manuscript that while we observe significant change within most racial and ethnic groups, SMM rates are not different between groups?

2. Lines 23 to 26. The authors should revise this to state their primary finding. That is that increases in the SMM rates was due to increases in age-specific rates.
   
   **Author’s Response:** Thank you for this feedback. We have revised these lines to state our primary finding as follows:

   **Changes to Manuscript:** Revised p. 2, lines 23-26: “Except among certain racial groups, increases in US population-level SMM rates over the last decade were due to increases in age-specific rates rather than shifts to older maternal age among the birthing population. Increasing SMM rates across the maternal age spectrum could indicate worsening pre-pregnancy health status of the birthing population.”

3. Lines 234 to 244. Some other limitations that may need to be pointed out. I am assuming that the NIS dataset analyzed was for inpatient admissions with delivery. This does not reflect SMM rates that may have occurred with a postpartum readmission or up to one year postpartum. Further, understanding the conclusion could be that pre-pregnancy health status may be worsening, no adjustment for comorbidities was undertaken between the two time periods.

   **Authors’ response:** Thank you for highlighting these additional limitations, and we agree that these are important to include to contextualize our findings. We have added these to our limitations section in the Discussion.

   **Changes to manuscript:** Edited p. 11, lines 276-293: “This study has some limitations. Our analysis only assessed SMM during the delivery hospitalization, and did not capture SMM occurring during the postpartum period. Changes in ICD revisions during our study period could have influenced observed trends; we were unable to assess this as CDC-
published comparability ratios for SMM indicators were not available at the time of analysis. However, a recent evaluation of this issue found no significant impact of the ICD9/10 transition on overall SMM and the majority of SMM indicator trends nationally, though changes in some indicators (particularly decreases in DIC) were associated with the revision. While our findings could indicate that pre-pregnancy health status may be worsening among the reproductive-age population, we were unable to evaluate this hypothesis directly as our decomposition of change between the two time periods focused on isolating the effect of maternal age shifts and it did not adjust for comorbidities. It also was not possible to examine the role of nulliparity with this data, which may compound risks associated with advanced maternal age. The NIS captures Hispanic ethnicity as the primary categorization, regardless of the patient’s race, and thus we were unable to assess heterogeneity among Hispanic individuals by race. Finally, due to few observations, we could not examine age-specific trends by race and ethnicity for each SMM indicator."

4. Line 241 (minor point). Did you mean for this to the "third" point and not the "fourth?"

Authors’ Response: Thank you for catching this error. For grammatical flow, have removed the numbering language, including this typo, from this paragraph after adding more limitations based on Editor and Reviewer feedback.

Changes to Manuscript: Edited p.11, line2 276-298: Removed numbering language to list of limitations.

* Help us reduce the number of queries we add to your manuscript after it is revised by reading the Revision Checklist at [https://nam02.safelinks.protection.outlook.com/?url=https%3A%2F%2Fjournals.lww.com%2Fgreenjournal%2FDocuments%2FRevisionChecklist_Authors.pdf&data=05%7C01%7Cblair.berger%40jhu.edu%7C2ef6525e4fa749ebbcfb08db20e7ab74%7Ca4f438b1e6473b803f86f8aedf0dec%7C0%7C0%7C638139951612496966%7CUnknown%7CpGbGZsb3d8eyJWljoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C000%7C%7C0%7C%7%26data%3D%2F6qhVvySp1PSnVUyEuqyFL69%2FentdGAoPWOWiD5yi9Q%3D&reserved=0 and making the applicable edits to your manuscript.

Author’s Response: We have gone through to ensure adherence with the Revision Checklist, including “un-blinding” the name of our clearing IRB.

* Figures 1-2: Please upload as individual figure files on Editorial Manager.

Author’s Response: We have removed these figures from the Tables document and uploaded them as individual figure files.

REVIEWSER COMMENTS:

REVIEWSER #1:

Introduction
1. The expectation for the analysis is that the changing profile in maternal age isn't going to be a major determine of SMM because increases in maternal age over the study period haven't been that dramatic.

Authors’ response: Thank you for raising this point. We will respond to this comment here in tandem with Reviewer’s comments #8 and #11 that similarly raise this issue. While the absolute in increase in proportion of births to people of advanced maternal age (35+ years) during our study period was 3.3%, this constitutes a relative increase of 18%. We note that this relative increase varies substantially when we look at changes within racial and ethnic groups; on the lower end, increases among non-Hispanic White and Asian/PI individuals ranged between 9-10%, while we documented significant relative increases among groups we know are disproportionately burdened by SMM, including 36.4% among non-Hispanic Black, 41.2% among Hispanic persons, and 33.4% among AI/AN persons (though power was insufficient among AI/AN to infer a significant increase at a threshold of p<0.001). In response to comments from Reviewer #2 and the Statistical Editor, we have added notations in Table 1 to highlight significant differences in maternal age distributions between 2008-09 and 2017-18.

Our observed shifts to later maternal age are in line with what has been reported by NCHS, which show sustained and marked increases in both births to people 35 years and older over the last 30 years, as well higher mean age at birth (particularly first births), overall and among all racial and ethnic groups1,2,3. To underscore this point more clearly in the background and to set the motivation for our analysis, we have added these points and citations to our Introduction. We agree with the Reviewer that shifts in later maternal ages during our observed study period may not yet have been large enough to have substantial impact on population-level SMM rates; we acknowledge this point on p.12, lines 284-293. However, we were still somewhat surprised by our finding given the known risks of SMM that increase with age; we expected to see that shifts in maternal age composition that would have explained at least some of the observed secular shift particularly in SMM with transfusion rates, given we observed significant changes in maternal age structure overall and across racial/ethnic groups while observing fewer significant age-specific rate changes. As the research remains unclear about the reasons underlying this increase in SMM in the US, we sought to test a common explanation tying the increase to shifts to later childbearing from a demographic perspective by looking at the most recent 10-year data period of the current US maternal health crisis available to us. We watch with interest to see as delayed childbearing becomes more prominent if current trends persist, especially among demographic groups who historically had births at younger ages, whether the impact of maternal age shifts could have greater influence on SMM trends than what we observed in this study.


Changes to Manuscript: Edited Table 1- added symbols to 2 table columns. Footnote added to T1 Note: “Rates shown reflect weighted estimates. –Cells suppressed for n=11. P-values for differences based on Rao & Scott second-order corrected Pearson statistics:
+++ (p<0.001); P-values for differences between rates based on tests for equality of weighted proportions: *** (p<0.001). AI/AN= American Indian/Alaskan Native; NH=Non-Hispanic; Other/Multi= Other race or multiracial; PI= Pacific Islander; SMM= severe maternal morbidity; UR= Unreported Race.”

Edited Introduction p.2, lines 33-40: “The reasons for this upward trend in SMM are not well understood. One proposed but understudied explanation relates to a key demographic change the US birthing population: the shift of childbearing to later ages.6 The proportion of births to women over the age of 35 has doubled since 1990, comprising about 20% of births in 2021, while birth rates among people in their 40s have steadily increased during this time6,7,8. Mean maternal age, particularly the mean age at first birth, has also increased between 2009-2021 among all racial and ethnic groups 6,9. Because the risk of SMM increases with maternal age,9,10 it seems plausible that at least some of the secular trend in SMM might be due to the shift in the maternal age distribution.

Methods
2. Why not compare trends continuously from 2008 to 2018? Data from 2020 is out. Why not analyze 2008 to 2020? It's been a while since 2018 was the most recent iteration (>2 years).
(Ah OK I see later on that you analyze 2008-2018. This is confusing. It would be better to say earlier on that you have access to that sample and then are making a specific comparison between the beginning and end of the study period.)

Authors’ response: Thank you for this input. We have edited the first line of the Methods section to indicate we assess annual SMM trends between 2008-2018 in addition to the decomposition analysis. In terms of data availability, we agree decomposing change between 2008-2020 would have been of value, but 2018 was the most recent data year available to us at the time of our data issuance and analysis; we acknowledge this point in lines p.3, 55-58.

Changes to Manuscript: Edited p. 3 lines 51-54: We assessed annual trends in SMM rates between 2008-2018, and we conducted a pooled cross-sectional decomposition analysis comparing delivery hospitalizations from two time points (2008-2009 to 2017-2018) using administrative hospital discharge data from the National Inpatient Sample (NIS).12

3. Why do you combine years e.g. 2008 and 2009? The NIS is a sample that creates national estimates. You could just compare 2008 to 2018.

Authors’ response: Thank you for raising this question. We will address this comment in tandem with the Reviewer’s comment #5, which also raises the point about conducting our decomposition analysis comparing pooled 2-year periods. As we outline in pages 4-5, lines 97-101, we conducted this analysis using pooled 2-year periods to obtain stable estimates. While we employ this rationale for our whole analysis, this pooling particularly aids in the precision of our estimates comparison of indicator-specific SMM rates between 2008-2009 and 2017-2018; as the current literature base on
SMM is limited in terms of temporal comparisons of SMM indicators, we consider this part of our analysis a valuable contribution. In comparing combined-year periods, we also comport with current literature on SMM that conduct pooled analyses of this important outcome, that while more common and thus more easily assessed than maternal mortality, is still relatively uncommon epidemiologically at population level (<10%). Our analysis of yearly trends between 2008-2018 overall and by race and ethnicity (Figure 1, Supplemental Figure 1) yields nationally-representative yearly estimates, which we include to contribute to a comprehensive assessment of temporal changes in SMM during this decade in the US.

Changes to Manuscript: N/A

4. Line 62-64 The info on the 'primary sample' is confusing, because you say you will apply weights but those aren't the weighted estimates.

Authors’ response: Thank you for this feedback. We have clarified our language in the manuscript to explicitly differentiate our reference to weighted and unweighted estimates in response to both this comment and the Reviewer’s comment #7.

Changes to Manuscript: Revised p.3, lines 67-69: “Our primary analytic sample included 1,687,748 (2008-2009) and 1,467,786 (2017-2018) unweighted delivery hospitalizations to people 11-55 years of age, representing 7,985,930 and 7,338,825 weighted delivery hospitalizations during these respective time periods. We conducted a descriptive yearly trend analysis with a secondary sample of unweighted 8,508,612 delivery hospitalizations to patients in the same age range between 2008-2018, representing a weighted estimate of 41,608,950 delivery hospitalizations in the US during this decade.”

5. Line 87-88 ‘Except for yearly trends in SMM rates between 2008-2018, SMM rates at two time points (2008-2009 and 2017-2018) were pooled over 2-year periods to obtain stable estimates.’ Large sample with common outcome - you shouldn't need to pool to get stable estimates.

Authors’ response: Please see our response to the Reviewer comment #3 above addressing this point.

Changes to manuscript: N/A

6. Line 89-90 'Maternal age groups were assessed as: <20, 20-24, 25-29, 30-34, 35-39, 40-44, and 45+90 years' Risk goes up with age <18 - not sure why 18 and 19 year olds were included in this category.

Authors’ response: Thank you for raising this point. We acknowledge that very young adolescents have a particularly high risk of SMM, though overall numbers in this <18 category are quite small. We utilize the maternal age groups the reviewer lists above, including a <20 category for adolescents, commonly used in maternal and perinatal health research to which we compare our results. These age categories are also in line
with standard maternal age categories outlined in federal agency guidance on SMM stratifications by age (see as one example this guidance from MCHB: Maternal and Child Health Bureau Federally Available Data (FAD) Resource Document. April 1, 2023; Rockville, MD: Health Resources and Services Administration. Available at: https://mchb.tvisdata.hrsa.gov/Home/Resources). Where we deviated from the standard 5-category maternal age groups is in separating 40-44 and 45+ year age groups from the typical advanced maternal age group of 35+ years. We did this so that we could assess with more specificity the common hypothesis that older maternal age is driving the upward shift in population-level SMM than the combined 35+ advanced age grouping allows.

Changes to Manuscript: N/A

Results

7. You only have 3 million+ estimated deliveries total? I don't think you applied weights correctly. For 4 year period you should have 14-16 million delivery hospitalizations.

Author’s Response: Thank you for raising this issue. Our reference to ~3 million deliveries is referring to the unweighted deliveries we analyze in our primary analytic sample, not the weighted estimate they represent. To clarify this, we have edited the text to add “unweighted delivery hospitalizations” whenever we refer to unweighted numbers, and we have added the weighted estimated deliveries these numbers represent. We applied HCUP’s standard weighting for pre- and post-2012 yearly samples to generate these estimates in our weighted analyses.

Changes to Manuscript: Revised p.3, lines 67-69: “Our primary analytic sample included 1,687,748 (2008-2009) and 1,467,786 (2017-2018) unweighted delivery hospitalizations to people 11-55 years of age, representing 7,985,930 and 7,338,825 weighted delivery hospitalizations during these respective time periods. We conducted a descriptive yearly trend analysis with a secondary sample of unweighted 8,508,612 delivery hospitalizations to patients in the same age range between 2008-2018, representing a weighted estimate of 41,608,950 delivery hospitalizations in the US during this decade.”

8. AMA deliveries only increased 2.3% which is intuitive and what would be expected from the natality statistics.

Authors’ response: Thank you for your comment. Please see our response to the Reviewer’s comment #1 that also raises this point, which contextualizes our findings in the context of a 3.4% absolute increase in births to AMA.

Changes to Manuscript: N/A

9. Line 155-159 - you should probably include some risk estimates here.

Authors’ response: Thank you for this input. We have edited this section to address this
comment, as well as comments from Reviewer 2 and the Statistical Editor, to add to explicitly highlights age strata where we observed significant change (based on tests for equality of weighted proportions). We also include more language around relative change to complement our relaying of absolute change results, which correspond to the values in the risk ratios the reviewer mentions we include in the decomposition table (T2).

Changes to Manuscript: Edited p. 8, lines 167-185:

“Across racial and ethnic groups, SMM rates significantly increased between 2008-2009 and 2017-2018 among AI/AN, Asian/Pacific Islander, Black, and White persons (p<0.001 based on tests for equality of weighted proportions). SMM rates among all deliveries significantly increased during these time periods all age groups <40 years of age, corresponding to relative increases ranging from 12-35%. Overall non-transfusion SMM rates similarly increased during this time for all age groups, except among people aged 30-34 years for whom rates remain relatively stable or decreased; however, significant increases in non-transfusion SMM rates within age strata were only observed among all deliveries <20 years of age, Hispanic people ages 25-29 (p<0.001 based on tests for equality of weighted proportions). SMM rates increased for all racial and ethnic groups except those of Other race/Multiracial or unreported race, with the biggest increases at 73% and 47%, respectively, occurring among people identified as AI/AN from 160.2 to 277.1 per 10,000 and Asian/Pacific Islander individuals from 123.9 to 182.6 per 10,000. Non-transfusion SMM rates increased overall and for Black, Hispanic, Asian/Pacific Islander, AI/AN, a remained relatively stable for White people, Other Race/Multiracial people, and those with unreported race. The largest increase in non-transfusion SMM rates was again observed among AI/AN and Asian/Pacific Islander individuals with a relative increase of 82% (57.7 to 105.2 per 10,000) and 42% (52.1 to 74.0 per 10,000), respectively. Black and AI/AN individuals had the highest SMM and non-transfusion SMM rates of any group during either time period.”

10. There's a lot of discussion of differentials by race in results, but the study title, the abstract, and the intro focus on age, not race.

Author’s response: Thank you for raising this point. We agree that our original introduction did not adequately set the rationale for stratifying our decomposition analyses by race and ethnicity. Working within journal format guidelines on the study title, we chose to focus our verbiage there on the overall focus of the paper. In our revision, our abstract retains the line in the Methods “Analyses were stratified by race and ethnicity,” and we retain our abstracted results and conclusion that highlight our findings by race and ethnicity. We have edited the Introduction, within journal format word limit guidelines, to provide more background context that motivates for conducting our analyses by race and ethnicity. We discuss this point further in response to Reviewer #1’s comment #14, which raises a similar point.

Changes to Manuscript: Edited p.2, lines 33-45 in Introduction: The reasons for this upward trend in SMM are not well understood. One proposed but understudied explanation relates to a key demographic change the US birthing population: the shift of childbearing to later ages.6 The proportion of births to women over the age of 35 has doubled since 1990, comprising about 20% of births in 2021, while birth rates among people in their 40s have steadily increased during this time6,7,8. Mean maternal age,
particularly the mean age at first birth, has also increased between 2009-2021 among all racial and ethnic groups\textsuperscript{6,9}. Because the risk of SMM increases with maternal age,\textsuperscript{9,10} it seems plausible that at least some of the secular trend in SMM might be due to the shift in the maternal age distribution.

Using demographic decomposition methods, we quantify how much of the observed increase in SMM at the population level is due to changes in the shifting maternal age structure, and how much is influenced by changes in age-specific SMM rates. We also analyze how these patterns differ by race and ethnicity given differences in both the maternal age distribution and rate of childbearing postponement by racial and ethnic subgroups.\textsuperscript{6,11}

11. Primary findings related to the proportion of morbidity accounted for by age are intuitive.

**Authors’ response:** Thank you for your comment. Please see our response to the Reviewer’s comment #1 that also raises this point.

**Changes to Manuscript:** N/A

12. Why not trend SMM by age group over entire study period in a figure? Why not trend age groups of deliveries over entire study period?

**Authors’ response:** Thank you for this comment. While we see merit and interest in the types of trends the Reviewer mentions, our figures and descriptive table in Table show the relevant descriptive statistics that directly set the stage for the Kitagawa decomposition analysis we conduct in this study. This type of analysis uses discrete time points, often 2-4, as anchors to determine the impact of a particular factor (in this case, changing maternal age structure) on the observed change in a rate overall. To draw a line directly to our decomposition analysis, we showed what the trend in overall SMM rates were that we decomposed, age-specific rates for our anchored time-points, as well as what the change in the maternal age distribution was (we chose to show this trend in maternal age distribution both in table form and graphically change in Figure 2 as percent change between time points).

**Change to the Manuscript:** N/A

Discussion
13. The immediate question is to what degree age effects are a proxy for increased risk for a number of comorbid conditions in this population. Is the driver of increasing morbidity underlying comorbid risk? There are a number of ways this could have been analyzed within this study. You could run regression models for SMM stratified by age group accounting for underlying comorbidity to estimate effects of year within each age category.

**Author’s response:** Thank you for raising these points, and we agree that the issue of comorbidity is an important next piece, as another common explanation linking age and
SMM is that older birthing people have more comorbidities. The Reviewer suggests a number of ways to assess this question from an epidemiologic perspective. Our goal in this study was to isolate the effect of maternal age from a demographic perspective; we discuss this paradigm further in our response to the Reviewer’s comment #14 in the context of race and ethnicity, which also applies to this point about risk adjustment for comorbidities. Overall, we believe this demographic perspective on SMM will be of interest to clinical audiences as we add to the growing body of literature suggesting maternal morbidity appears to be worsening across the age spectrum, and this may point to worsening a pre-pregnancy health status among the reproductive age population. We hope our findings can inform clinical and practice efforts to identify and manage high-risk birthing patients, including patients ages 20-34 previously presumed to be low-risk, as one component of reducing and preventing maternal morbidity and mortality.

We agree that our findings related to isolating the impact of maternal age shifts raises others about the role of comorbidities, particularly as we suggest that our findings may indicate a decline in pre-pregnancy health status. Based on feedback from the Editor, we have added language in our Discussion that explicitly acknowledges as a limitation that our analysis does not adjust for comorbidities. We also expound in the discussion section on recent population-based research using data from California that pre-pregnancy health did not explain increasing SMM.1 We discuss a recent decomposition analysis that interestingly found population-level increasing rates of comorbidities among birthing people were not attributable to shifts toward advanced maternal age, notwithstanding that rates of comorbidities increased with age2.

We interpret our results in context of this existing research, and we view understanding the role of comorbidities as an important next research step—put briefly, if we infer in this study that what is driving up SMM does not appear to be shifts to older maternal age, then what is driving it? Isolating the role of comorbidities across the maternal age spectrum is a next step. As new research continues to add to this body of literature, we look forward to continuing to assess this question; we acknowledge the limitation of this current analysis in not including it.


Changes to Manuscript: Edited p. 12, lines 289-292: “While our findings could indicate that pre-pregnancy health status may be worsening among the reproductive-age population, we were unable to evaluate this hypothesis directly as our decomposition of change between the two time periods focused on isolating the effect of maternal age shifts and it did not adjust for comorbidities.”

Edited p. 12, lines 298-311: “Taken together, our results suggest that factors other than maternal age shifts have primarily driven increases in SMM in the US over the last decade. One leading explanation for increasing rates of SMM is that pre-pregnancy health among the birthing population is worsening across the age spectrum.30-33 Indeed, recent research analyzing trends in morbidity and mortality among reproductive-aged females shows concerning trends across both younger and older groups.30,33,34 However, a
population-based analysis using data from California found that pre-pregnancy health did not explain increases in SMM in that state between 2007 and 2014. Similarly, a recent decomposition analysis found that population-level increasing rates of comorbidities among birthing people in California between 1991-2012 were not attributable to shifts toward advanced maternal age. Other explanations may include increasing prevalence of obstetric interventions, access to quality obstetric care, and the impact of structural factors and systemic inequality on the health trajectories of birthing people across the life course, which all require further study.”

14. Overall the stratification of trends and outcomes by race doesn't make too much sense to me. What was the specific purpose of disaggregating by race? We already know there are differentials in risk by race by age group with older black women at highest risk.

**Author’s response:** Thank you for your question. The purpose of disaggregating our analyses by race and ethnicity were to: 1) provide annual SMM rates between 2008-2018 by race and ethnicity (Supplemental Figure S1), 2) add a layer to our decomposition analysis. Taken together, we view these as enhancing a more comprehensive understanding of the impact of shifting maternal age structure on increasing SMM rates, given the well-documented differences between racial and ethnic sub-groups in SMM, maternal age distribution, and the rate of childbearing postponement.

We agree with the Reviewer’s point that there are known SMM risk differentials by race, with Black people of advanced maternal age at highest risk. We would note that our analysis comes at this question from a different angle—rather than operating in a paradigm of epidemiologic risk (i.e., who is at higher risk compared to others, within a regression framework), our analysis uses a demographic perspective: While both race and advanced maternal age are known individual-level risk factors for SMM, our decomposition analysis instead looks at whether population-level increases in SMM over time is attributed to population-level shifts toward older maternal age. We further examine increases in SMM rates observed for all racial and ethnic groups. The goal in the stratified analysis is to assess at demographic age changes attributable to increases in SMM *within* racial and ethnic sub-groups, not a relative risk comparison of which racial or ethnic sub-groups are at higher risk of SMM; considerable existing literature has documented the latter. Our findings suggest that population-level shifts toward older childbearing is not a primary driver overall and for most racial and ethnic (at least during this time frame), but we do see that in contrast, shifting maternal age structure is part of the story (about 17-34%) for increasing SMM among Black birthing people. We think documenting and understanding these kinds of differences by race and ethnicity are important in the context of stark and persistent racial and ethnic disparities in SMM.

We have found limited literature documenting recent population levels in both maternal age distributions and SMM rates in parallel by race and ethnicity, and we hope these elements of our study will be a contribution to this gap. Prior research is often limited by small sample sizes that do not allow for adequate stratification by both age and race/ethnicity; we wanted to leverage the large NIS dataset to report nationally-weighted estimates for as many racial and ethnic sub-groups as we could; notably, we though we had to suppress some age strata cells in certain racial and ethnic groups due to low frequency. We were unable to carry out these dual-stratifications in our assessment of
changes in indicator-specific SMM rates, which we acknowledge in our limitations section.

As we mentioned in Reviewer 1’s comment #10, we have edited our Introduction to provide a clearer grounding and context that motivates for conducting our analyses by race and ethnicity.

**Changes to Manuscript:** Edited p.2, lines 33-45 in Introduction: The reasons for this upward trend in SMM are not well understood. One proposed but understudied explanation relates to a key demographic change the US birthing population: the shift of childbearing to later ages.6 The proportion of births to women over the age of 35 has doubled since 1990, comprising about 20% of births in 2021, while birth rates among people in their 40s have steadily increased during this time6,7,8. Mean maternal age, particularly the mean age at first birth, has also increased between 2009-2021 among all racial and ethnic groups 6,9. Because the risk of SMM increases with maternal age,9,10 it seems plausible that at least some of the secular trend in SMM might be due to the shift in the maternal age distribution.

Using demographic decomposition methods, we quantify how much of the observed increase in SMM at the population level is due to changes in the shifting maternal age structure, and how much is influenced by changes in age-specific SMM rates. We also analyze how these patterns differ by race and ethnicity given differences in both the maternal age distribution and rate of childbearing postponement by racial and ethnic subgroups.6,11

**REVIEVER #2**

Obstetrics and Gynecology
Manuscript #ONG-23-353

"The role of maternal age in increasing severe maternal morbidity rates in the US"

**GENERAL**

This study reviews the NIH inpatient database for severe maternal morbidity variables at two separate intervals to isolate the contributory effect of maternal age on rates.

1. The manuscript is extremely articulate and well-organized.
   **Authors’ response:** We appreciate this feedback.
   **Changes to Manuscript:** N/A

2. Does the source data permit determination of multiple deliveries to the same individual?
   **Author’s response:** Thank you for raising this question. Individuals cannot be identified in the NIS, only hospital discharges. As we mention on p.3 lines 62-66, “Consistent with methodological standards for analyzing NIS data,13 our units of analysis were delivery hospitalizations (unique individuals cannot be identified in NIS data), and all analyses
were weighted to account for the complex sampling scheme of the data and to obtain nationally-representative estimates. For ease of interpretation, we refer to the sample as people or individuals throughout the manuscript, as done by others.14**

**Changes to Manuscript:** N/A

3. Given the discussion regarding transfusion and non-transfusion severe maternal morbidity (SMM) rates (Lines 78-87), do the authors feel overall SMM rates represent a valid measure? (or perhaps only the relative change in SMM)?

**Author’s response:** Thank you for this question, and it is one we continue to consider as new research in this area is published. We present both SMM and non-transfusion SMM rates in this study for a couple of reasons. We used the 21-indicator CDC algorithm as the primary method to identify SMM in this study; CDC guidance at the time of this submission still includes blood transfusion in its SMM case identification criteria. We also wanted to acknowledge new ancillary federal agency guidance (MCHB, AHRQ) cautioning the inclusion of transfusions in identifying true severe morbidity, and we outline the issues regarding transfusions recent research has identified. While there remains a lack of consensus on SMM case identification and considerable movement in new SMM measurement validation studies, we await updated guidance from major federal agencies moving forward. In this study, we present both rates to give a comprehensive view, and to comport with prior SMM literature that often report both rates, against which we compare and contextualize our findings in the Discussion.

**Changes to Manuscript:** N/A

4. What does the phrase "growing structural inequality across the life course" mean? Consider rephrasing in more conventional terminology.

**Authors’ response:** Thank you for this comment. We have edited this phrase as follows:

**Changes to Manuscript:** Edit lines p. 12-13, 307-311: “Other explanations may include increasing prevalence of obstetric interventions, access to quality obstetric care, and the impact of structural factors and systemic inequality on the health trajectories of birthing people across the life course, which all require further study.”

5. Does the source data permit distinguishing singleton from multiple gestations? If so, the (possible) incremental increase of multiple over singleton pregnancies at the specific age ranges would be of additive value for counseling.

**Authors’ response:** The Reviewer raises an interesting point. Yes, multiple gestations are distinguishable in NIS data. When we looked into trends in multiple gestations over the study period in addressing the Reviewer’s comment, we observed minimal change in the multiple birth rate during the time period of interest (about 3.2% in 2008-09 to 3.4% in 2017-18). Stable rates, coupled with recent evidence that suggests multiple birth rates were stable, then declined beginning in 2009 through the study period, including declines in multiple gestations across maternal age strata in the US1-2,3, we suggest differential multiple birth rates by age may not be playing a significant role in our demographic
understanding of the relationship between older maternal age and population-level SMM during this time period, and thus is beyond the scope of this analysis. However, the reviewer’s point is well-taken, particularly as it relates to the growing body of research linking delayed childbearing, assisted reproductive technology (and comorbid conditions that pose risks to fertility) and SMM, which may have implications for clinical counseling related to multiple gestations and SMM risk among patients utilizing ART. While beyond the scope of this analysis, we continue to watch for new research in this area with interest.


**Changes to manuscript:** N/A

6. Consider commenting in the Discussion what the authors would consider to represent a significant change in SMM rates (i.e., Line 217 - would <2% range represent a clinically significant difference?).

**Author’s response:** Thank you for this input. Based on the feedback from Reviewer 2’s comment #7 and the Statistical editor, we have added notations in Tables 1 and 2 highlighting significant change in SMM rates and maternal age distributions between time periods. We have also edited language throughout the Results and Discussion sections to explicitly refer to findings where we observe significant change, both absolute and relative. We hope these edits help underscore those findings for which we saw the most significant and impactful changes.

In the line the Reviewer mentions above, we have edited that line to clarify <2% refers to relative change.

**Changes to Manuscript:** Edited p. 11, line 241-242: Among White individuals, changes in non-transfusion SMM rates were driven by changes in the maternal age distribution, though the relative increase in non-transfusion SMM among this group was quite small (less than 2%).

Edited p.7-8, lines 152-190: “Significant increases in annual rates were observed for both types of SMM among all racial and ethnic groups except for non-transfusion SMM among delivery hospitalizations to White persons and people with unreported race (p<0.001 based on Cochran-Armitage test for trends) (Supplemental Figure S1). Table 1 shows the pooled rates of SMM by race and ethnicity and the maternal age distribution of delivery hospitalizations for 2008-2009 and 2017-2018. The pooled SMM rate increased between 2008-2009 and 2017-2008 from 141.9 to 167.2 per 10,000, corresponding to a nearly 18% relative increase. Overall, there was a shift in the maternal age distribution towards older age groups between these two periods (Table 1 and Figure 2). The proportion of deliveries to people under 25 years of age decreased across all racial and ethnic groups, declining from 34.1% among all delivery hospitalizations in 2008-2009 to
24.5% in 2017-2018 (with a relative decline of about 50% in the proportion of deliveries to adolescents). Delivery hospitalizations among people of advanced maternal age (35 years and older) increased from 14.6% to 17.9% overall, with larger increases occurring among people identified as Black (10.7 to 14.6%, a relative 35.4% increase), Hispanic (12.1 to 17.1%, a 41.2% increase), and AI/AN (9.8 to 13.1%, an increase of 33.4%). Across racial and ethnic groups, SMM rates significantly increased between 2008-2009 and 2017-2018 among AI/AN, Asian/Pacific Islander, Black, and White persons (p<0.001 based on tests for equality of weighted proportions). SMM rates among all deliveries significantly increased during these time periods all age groups <40 years of age, corresponding to relative increases ranging from 12-35%. Overall non-transfusion SMM rates similarly increased during this time for all age groups, except among people aged 30-34 years for whom rates remain relatively stable or decreased; however, significant increases in non-transfusion SMM rates within age strata were only observed among all deliveries <20 years of age, Hispanic people ages 25-29 (p<0.001 based on tests for equality of weighted proportions). SMM rates increased for all racial and ethnic groups except those of Other race/Multiracial or unreported race, with the biggest increases at 73% and 47%, respectively, occurring among people identified as AI/AN from 160.2 to 277.1 per 10,000 and Asian/Pacific Islander individuals from 123.9 to 182.6 per 10,000. Non-transfusion SMM rates increased overall and for Black, Hispanic, Asian/Pacific Islander, AI/AN, a remained relatively stable for White people, Other Race/Multiracial people, and those with unreported race. The largest increase in non-transfusion SMM rates was again observed among AI/AN and Asian/Pacific Islander individuals with a relative increase of 82% (57.7 to 105.2 per 10,000) and 42% (52.1 to 74.0 per 10,000), respectively. Black and AI/AN individuals had the highest SMM and non-transfusion SMM rates of any group during either time period.

7. Consider including columns in Table 1 highlighting the differences in each variable between the two-time intervals.

Authors’ response: Thank you for this suggestion. To address this comment and the Statistical Editor’s comment #2 that raises a similar point, we have added symbols designating significant differences between time periods in Table 1, utilizing an inference threshold of p<0.001. Significant differences between maternal age distributions in deliveries by race and ethnicity are (significant p-values for differences are designated with symbol “+”) based on Rao & Scott second-order Pearson statistics, given the complex weighting scheme of NIS data. Significant differences between time periods in SMM rates in Table 1(designated with the symbol “*”) are based on tests for equality of weighted proportions. We have added to the footnote to specify these symbols. We have edited our results (including the section of text in the previous comment) to highlight these significant differences.

Changes to Manuscript: Edited Table 1- added symbols to 2 table columns. Footnote added to T1 Note: “Rates shown reflect weighted estimates. –Cells suppressed for n<11. P-values for differences based on Rao & Scott second-order corrected Pearson statistics: +++ (p<0.001); P-values for differences between rates based on tests for equality of
weighted proportions: *** (p<0.001). AI/AN= American Indian/Alaskan Native; NH=Non-Hispanic; Other/Multi= Other race or multiracial; PI= Pacific Islander; SMM= severe maternal morbidity; UR= Unreported Race.”

REVIEWER #3

The authors have carried out a US population based study using data from the National Inpatient Sample to evaluate the impact of changes in maternal age over time on SMM. It is generally thought that the increase in SMM is driven primarily by the change in maternal age distribution over time. The authors compare two cohorts (from 2008-2009 with 2017-2018). The results are interesting, showing that apart from certain racial groups, the increase in older maternal age was not the primary driver of increasing SMM rates in the United States.

1. The study is very well-designed, and the manuscript is well written. It is easy to understand and straightforward. The length is appropriate, and not too long.
   
   Authors’ Response: We appreciate this feedback.

   Changes to Manuscript: N/A

2. The tables and figures are well laid out.
   
   Authors’ Response: Thank you for this feedback.

   Changes to Manuscript: N/A

3. The major change due to maternal age in SMM was amongst Blacks where maternal age accounted for 17% of the changing SMM and 34% of the change in non-transfusion SMM. This is interesting. Perhaps the most intriguing finding is of the dramatic increase in SMM rates occurring among people identified as AI/AN (line 162–164). Can the authors explain this? While this was not the primary objective of this study, it certainly is important and of interest? Similarly, why do the authors think that the increase in transfusion rates was so high for people under 20 years old? (Line 189-190). Again, not the primary focus, but perhaps a line addressing these 2 important findings may be helpful.

   Author’s Response: Thank you for raising these points, and we agree the stark increase in SMM among AI/AN people is alarming. We unfortunately were not sufficiently powered to assess SMM indicators (as in Supplement Table S1) stratified by both maternal age and racial and ethnic groups, so we are unable to determine which SMM indicators in particular were driving the increasing rates we observe among AI/AN. We do know, however, that this was not just due to increasing blood transfusions since we observed this increase in non-transfusion SMM as well. We have added 2 lines in the Discussion related to these findings, as suggested by the Reviewer.

   We also find the increase in transfusions among adolescents curious, and the reasons for this are unclear. Recent research of CDC Wonder birth data assessing maternal and perinatal complications among teen births between 2016-2019 suggests adolescents were at increased risk of transfusions and risk factors for transfusions (e.g., anemia) compared to counterparts >20 years of age\(^1\), though we cannot discern from this
analysis or other literature whether these rates have increased over time. However, given the considerations about blood transfusion measurement we discuss in lines 86-99, we are reluctant to include speculations in the Discussion about observed changes related to transfusion rates in particular; this may be an artifact of the ICD-9/10 transition\(^2,3\), and this increase may not signal increased obstetric severity among young people since we cannot discern volume of transfused units in the ICD codes.


**Changes to Manuscript:** Edited p. 11, line 258-263: “We observed both the highest rates and starkest increase in SMM among AI/AN individuals, whose change was driven by increasing age-specific SMM rates. These findings are particularly concerning given AI/AN birthing people are disproportionately burdened by the US maternal health crisis, and mortality rates among AI/AN women of reproductive have been persistently increasing over the last 20 years.\(^{34}\)”

4. In line 181 to 182, did the authors intend to put a slash between "Hispanic people" and "those of other race"?

**Authors’ Response:** Thank you for catching this error. We have corrected the grammar in this line below:

**Changes to Manuscript:** Edited p.9 line 211: “Shifting maternal age composition accounted for nearly 35% of the increase in non-transfusion SMM among delivery hospitalizations for Black persons, and about 20% the increases in rates among Hispanic people and those of Other races/Multiracial.”

5. Overall, a well designed and written study that may help us understand change in maternal SMM in relation to age and may provide some insight that may help direct potential interventions.

**Authors’ Response:** Thank you for this comment, we appreciate your review of this manuscript.

**Changes to Manuscript:** N/A

**STATISTICAL EDITOR COMMENTS:**

1. Lines 47-49 and 87-88: Should clarify in lines 47-49 that each time period was inclusive, i.e,
two full years, so that the total deliveries in subsequent tables were consistent with ~ 20% of total US deliveries during a two-year period.

Authors’ response: Thank you for raising this point. We have edited this section with the underlined language below to clarify that we used inclusive time periods.

Changes to Manuscript: Edited p. 3 line 51 “We assessed annual trends in SMM rates between 2008-2018, and we conducted a pooled cross-sectional decomposition analysis comparing delivery hospitalizations from two time points (2008-2009 to 2017-2018) using administrative hospital discharge data from the National Inpatient Sample (NIS).”

Edited p. 4-5 line 96-101: “Except for yearly trends in SMM rates between 2008-2018, SMM rates at two inclusive time points (2008-2009 and 2017-2018) were pooled over full 2-year periods to obtain stable estimates, representative of ~20% of US delivery hospitalizations during these time periods.

2. Table 1: Should note that the "UR" unreported race is the 3rd largest cohort among 7 in 2008-2009, larger than reported Black, Asian, AI/AN, yet became the 6th out of 7 in 2017-2018. In the first time period, UR comprised ~ 17% vs ~ 4% in the two time periods. Thus, comparisons by race, especially for the smaller groups, are subject to selection bias and imprecision. Were there any other categories of missing data for race/ethnicity? Also, the group AI/AN especially and to a lesser extent, the groups Asian/PI or Other/Multi have relatively fewer deliveries and thus fewer deliveries in the various age strata. Thus, estimates of SMM have more imprecision and are more difficult to sequentially compare. Should indicate in Table where there are statistically significant differences between time periods, but should employ a stricter inference threshold than < 0.05, owing to the multitude of comparisons and thus multiple hypotheses being tested.

Authors’ response: Thank you for raising these points. We will first respond to the question about whether there are other categories of missing race/ethnicity data—no, there were not. All missing data for this variable is captured in the “UR” category. In response to the Statistical Editor’s and Reviewer #2 comment #7 about indicating significant differences between time periods for each stratum, we have added symbols designating significant differences between time periods in Table 1, and we have re-run this analysis using an inference threshold of p<0.001, given the multiple comparisons the Statistical Editor notes. Significant differences between maternal age distributions in deliveries by race and ethnicity are (significant p-values for differences are designated with symbol “+”) based on Rao & Scott second-order Pearson statistics, given the complex weighting scheme of NIS data. Significant differences between time periods in SMM rates in Table 1 (designated with the symbol “*”) are based on tests for equality of weighted proportions. We have added to the footnote to specify these symbols.

Changes to Manuscript: Edited Table 1- added symbols to 2 table columns. Footnote added to T1 Note: “Rates shown reflect weighted estimates. –Cells suppressed for n<11. P-values for differences based on Rao & Scott second-order corrected Pearson statistics: +++ (p<0.001); P-values for differences between rates based on tests for equality of weighted proportions: *** (p<0.001). AI/AN= American Indian/Alaskan Native;
NH=Non-Hispanic; Other/Multi= Other race or multiracial; PI= Pacific Islander; SMM= severe maternal morbidity; UR= Unreported Race.”

Edited limitations section in Discussion, p. 12 line 289: “People with unreported race comprised 17% in 2008-2009 compared to 4% in 2017-2018, which could indicate some selection effects in this category.”

3. Table 2: It should be noted that among the RRs that are significantly different from the null, several of the differences are numerical, not statistical differences between pairs of RRs (or of ratios of RR). For SMM, the RRs for White, Black and Hispanic are statistically indistinguishable, while all three are statistically significantly different from AI/AN and Asian, while the latter two are indistinguishable from each other. For Non-transfusion SMM, now White is NS, Black and Hispanic are indistinguishable from each other, as are AI/AN and Asian, while the members of each like pair are statistically significantly different from each member of the other like pair. Should also include CIs for the 4 columns following RRs and indicate which show statistically significant changes over the time periods in question.

Author’s response: We appreciate this detailed feedback. We have included symbol notation indicating statistically significant changes in the SMM Rate Ratios between time periods, using an inference threshold of p<0.001.

The 4 columns following the rate ratios contain absolute values for the change in age-specific rates and maternal age composition, as well as relative proportions signifying the contribution of these components. We derive these values from the the Kitagawa decomposition formula in line 122, which is essentially a balancing equation to standardize and compare rates; this is why we did not include CI’s for these columns, as is common in Kitagawa tables displaying components of temporal change. To clarify, we have added “absolute” to the column headings in Table 2 to indicate “Absolute Change in Age-Specific Rates,” and “Absolute Change in Maternal Age Composition.”

We note the overlap in SMM rate ratios between racial and ethnic groups, and the Statistical Editor’s points about this overlap are well-taken. Our focus in the analysis where we stratify decompositions by race and ethnicity is to assess components of change in SMM rates within racial and ethnic subgroups between time periods as standalone strata. We thus discuss our results in the context of within-group change, rather than comparing the relative risk of SMM between groups to document disparities. **We would like to clarify the ask from the Statistical Editor on this point: is this comment requesting that we note in the manuscript that while we observe significant change within most racial and ethnic groups, SMM rates are not different between groups?**

Changes to Manuscript: Edited Table 2- added symbol notation indicating statistically significant changes in SMM Rate Ratios using an inference threshold of p<0.001. Added “Absolute” to columns displaying “Change in Age-Specific Rates” and “Change in Maternal Age Composition.”

4. Table 3 could probably be in supplemental material.
Authors’ response: Thank you for this suggestion. We have moved Table 3 to supplementary material as suggested.
Changes to Manuscript: Renamed Table 3 “Supplemental Table S1” and moved to Supplemental Material. Updates in the text referencing this table were updated accordingly. Previous Supplemental Tables S1 and S2 were renamed accordingly as “S2” and “S3.”