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Global maternal mortality associated with SARS-CoV-2 infection: a systematic review and meta-analysis

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ABSTRACT

Background Pregnant and recently pregnant women infected with SARS-CoV-2 are at increased risk of death and serious complications than those without the infection. The extent of variation in mortality rates in pregnant women with SARS-CoV-2 infection across regions, and the causes of death are not known. We systematically reviewed all available evidence on the variation in mortality rates in pregnant women with SARS-CoV-2 infection across geographical and country income groups, and the reported cause of death.

Methods We searched major databases (December 2019–January 2023) including Medline, LILACS, BIREME and Embase. We included studies that reported deaths in at least 10 consecutive pregnant or recently pregnant women with confirmed SARS-CoV-2 infection and assessed the studies' risk of bias. We calculated the summary estimates of any cause of death as proportions with 95% CIs using a multilevel random-effects logistic regression model. Subgroup analyses were performed by geographical region and country income groups. We used International Statistical Classification of Diseases and Related Health Problems-Maternal Mortality to categorise the reported cause of death.

Findings From 1 326 315 citations, we included 169 studies (319 172 women with confirmed SARS-CoV-2 infection; 4253 women died). The overall rate of unspecified maternal death was 0.87% (95% CI 0.64% to 1.16%). There were significant differences between geographical regions in rates of maternal mortality, with the highest rates in Sub-Saharan Africa (3.48%; 95% CI 0.66% to 16.42%) and Latin America and the Caribbean (3.16%, 95% CI 1.53% to 6.43%). Rates of maternal mortality varied by country income groups, with the highest rates in low-income countries (4.66%, 95% CI 0.75% to 24.07%). Among women with reported cause of death, 98.6% (2,390/2,423) of deaths were attributable to COVID-19.

Interpretation Rates of deaths in pregnant and recently pregnant women with SARS-CoV-2 infection vary significantly across regions and by country income groups, with the highest burden in Sub-Saharan Africa and low-income countries. COVID-19 is the main reported cause of death.

PROSPERO registration number CRD42020224120.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ The rates of SARS-CoV-2 infection vary across different geographical regions.
⇒ Pregnant and recently pregnant women with SARS-CoV-2 infection are at greater risk of developing complications compared with non-pregnant women of a similar age.
⇒ Non-white ethnicity, asthma, diabetes mellitus and chronic hypertension are known risk factors for maternal death in pregnant women with SARS-CoV-2 infection.

WHAT THIS STUDY ADDS

⇒ To our knowledge, this is the first evidence synthesis of cohort studies to estimate the rates of mortality of any cause in pregnant and recently pregnant women with SARS-CoV-2 infection over time and across different geographical regions, with the highest rate reported in Sub-Saharan Africa.
⇒ We determined the proportion of mothers who died from COVID-19 and pregnancy-related complications.
⇒ We found evidence of poor reporting of deaths of mothers.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ As the pace of the pandemic continues to evolve, with emergence of new virus variants, the spatial and temporal trends in SARS-CoV-2-associated maternal deaths should be monitored to identify countries in need of additional resources and guide clinical practice.

⇒ In the case of low-income countries which have so far suffered greatly, implementing measures to educate mothers of their mortality risk and clinicians to escalate the management of patients who are at greater risk of serious complications may prove beneficial.

INTRODUCTION

Pregnant women with SARS-CoV-2 infection are at greater risk of severe disease and death compared with their non-infected peers or non-pregnant women of reproductive age infected with SARS-CoV-2.[1] Inequalities in global maternal health existed before the pandemic, with disproportionately higher maternal mortality and morbidity in lower income countries compared with high-income countries.[2] The COVID-19 pandemic has posed a global risk to progress made in the Sustainable Development Goals target 3.1 of reducing global maternal mortality ratio to less than 70 per 100 000 live births by 2030.[3] Although there is evidence that the pandemic amplified existing health inequalities in the general population, little is known about the direct effects of SARS-CoV-2 on global maternal mortality rates.[4–6] Individual countries faced challenges obtaining high-quality data on SARS-CoV-2 infection and outcomes among pregnant populations. Robust tracing of outcomes like pregnancy-related mortality with COVID-19 was especially difficult given disjointed reporting systems across local, national and global entities. Key data limitations such as inadequate testing early in the pandemic to determine infection rates, poor linkage between coronavirus surveillance and pregnancy registries and inconsistent case definitions and reporting protocols for severe outcomes like maternal death increased the difficulties in quantifying the magnitude of maternal mortality due to COVID-19 on a global scale.[7]

Deaths in pregnant women with SARS-CoV-2 infection may occur due to COVID-19-related factors—where the pregnancy is complicated by infection with SARS-CoV-2; through other non-COVID-19-related obstetric causes such as pre-eclampsia or progression of underlying comorbidities—where infection with SARS-CoV-2 was incidental; and where the death is coincidental and non-maternal.[1 8] Other systemic factors may indirectly influence outcomes, such as accessibility of healthcare services, the uptake of vaccine for immunisation and the effectiveness of containing the spread of SARS-CoV-2 in individual countries.[9] Studies report conflicting mortality rates in pregnant women with SARS-CoV-2 infection, particularly in women from low and middle-income countries.[10] These studies do not report how maternal mortality rates vary across geographical and economic regions, or assess the magnitude of differences if any. Identifying where and why pregnant women with SARS-CoV-2 infection die is essential to inform policy development and resource allocation in those regions, including prioritising vaccination for more vulnerable groups to reduce disease burden.

We carried out a systematic review and meta-analysis to map variation in mortality rates in pregnant and recently pregnant women with confirmed SARS-CoV-2 infection according to geographical region and country income level and ascertain the causes of death.

METHODS

We undertook the review using a registered protocol (PROSPERO CRD42020224120) and complied with Preferred Reporting Items for Systematic Reviews and Meta-Analyses reporting guidelines (online supplemental appendix 1).[11] Our systematic review builds on the prospectively registered living systematic review (PROSPERO CRD42020178076) to evaluate a series of research questions on SARS-CoV-2 infection in pregnancy.[11]

Search strategy and study selection criteria

We searched major electronic databases (1 December 2019 to 30 January 2023) including Medline, LILACS, BIREME and Embase, preprint servers, registries, government sources and websites that serve as repositories for SARS-CoV-2 infection studies reporting death as an outcome (online supplemental appendix 2). We did not apply any language restrictions. Our full search strategy has been previously reported.[1]

We selected the studies using a two-stage process by first screening the title and abstract of all citations, and then retrieving the full text of potentially eligible studies for examination. Independent reviewers undertook study selection, and any disagreements were resolved after discussion with a third reviewer. We included studies from registry data or hospital records where all pregnant and recently pregnant women with a confirmed diagnosis of SARS-CoV-2 infection during the study period were reported on and followed up to the postpartum period by study authors to ascertain mortality outcomes. Both comparative and non-comparative studies were included, provided they reported at least 10 consecutive pregnant or recently pregnant women with SARS-CoV-2 infection during pregnancy. We defined recently pregnant women to be those who were in the postpartum and postabortion period within 42 days of the end of pregnancy. Online supplemental appendix 2 provides details of the search strategy and databases.

Study quality assessment and data extraction

Two independent reviewers assessed the qualities of included studies using the tool by Hoy *et al*[12] and undertook data extraction. Studies at low risk of bias for internal validity had no evidence of measurement or analysis bias. For external validity, studies at low risk of bias had minimal evidence of selection or non-response bias. High-quality studies were those with an overall low risk of

bias. We extracted data on study design, setting, maternal characteristics, number of pregnant and recently pregnant women with SARS-CoV-2 infection and number who died, cause of death, clinical care received and perinatal outcomes using a prepiloted form. All authors of included studies reporting at least one pregnancy-related death were contacted and asked to provide additional details on the death using a customised template. Non-responding authors were contacted a maximum of two times.

Causes of deaths were categorised as COVID-19-related (where the pregnancy is complicated by infection with SARS-CoV-2), pregnancy-related (non-COVID-19-related obstetric death) and unrelated to either COVID-19 or pregnancy (coincidental death), through consensus of two independent reviewers, using the International Statistical Classification of Diseases and Related Health Problems-Maternal Mortality.[13 14] We conducted detailed deduplication by querying suspected duplicate data with study authors and checking if the characteristics of the mothers or neonates matched the setting, characteristics and duration of another study from the same geographical location. If multiple studies reported on the same cohort of women, studies with the larger sample sizes were included.

Data analysis

We summarised rates of any cause of death in pregnant women with SARS-CoV-2 infection as proportions with 95% CI using a multilevel random-effects logistic regression model.[15] Heterogeneity was reported using τ^2 statistics. We carried out subgroup analyses by geographical region (East Asia and Pacific, Europe and Central Asia, Latin America and the Caribbean, Middle East and North Africa, North America, South Asia) and World Bank country income groups (low income; lower middle income; upper middle income and high income).[16] Studies that reported results from multiple geographical regions were analysed together as a separate category. We performed sensitivity analyses by restricting the analysis to registry data, prospective study design and excluding studies with the largest sample size. All statistical analyses were done with StataSE (V.18). We used a narrative descriptive approach to summarise the causes of their deaths.

Role of the funding source

The funder of the study had no role in study design. Employees of the funder were involved in data collection, data interpretation and writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Patient and public involvement

This study is supported by Katie's Team, a dedicated patient and public involvement group in women's health. The team was involved in the interpretation and reporting of this systematic review through participation in virtual meetings. Findings will be made available on our website in a format more suitable for patients and members of the public (http://www.birmingham.ac.uk/research/who-collaborating-centre/pregcov/index.aspx).

RESULTS

After screening 7568 full-text articles from 1 326 315 identified citations, we included 169 studies reporting mortality outcomes in 319 172 pregnant and recently pregnant women with confirmed SARS-CoV-2 infection (figure 1).

Characteristics of included studies

Most included studies were from South Asia (55/169, 32.5%) followed by Europe and Central Asia (42/169, 24.8%), Middle East and North Africa (30/169, 17.8%), Latin America and the Caribbean (16/169, 9.5%), East Asia and Pacific (11/169, 6.5%), North America (7/169, 4.1%) and Sub-Saharan Africa (4/169, 2.4%). Four studies comprised populations from multiple regions (4/169, 2.4%). Seventy-nine studies (46.7%, 20 928 women) were from lower middle-income countries, 48 (28.4%, 2 07 743 women) from high-income countries, 35 (20.7%, 83 447 women) from upper middle-income countries and 3 studies (1.8%, 405 women) were from low-income countries. Four studies comprised populations from multiple countries of different income levels (2.4%, 6649 women).

Studies using registry data made up more than a third of the included studies (63/169, 37.3%), and contributed most of the included pregnant women (92.8%, 297 728/319 172). At least one pregnancy-related death was reported in 70% (119/169) of included studies (online supplemental appendix 3).

Quality of the included studies

Assessment of external validity showed a low risk of bias for representativeness in 36% (60/169) of studies, in 85% (143/169) for sampling bias, in 90% (152/169) for selection bias, and in 98% (165/169) for non-response bias. For internal validity, the studies had a low risk of bias for data collection in 66% (112/169) of studies, in 100% for case definition, in 100% for measurement bias, in 98% (165/169) for differential verification, in 100% for adequate follow-up and in 89% (150/169) for appropriate numerator and denominator. The overall risk of bias was low in 96% (162/169) studies and moderate in 4% (7/169) of studies (figure 2). Online supplemental appendix 4 provides the quality assessment of individual studies.

Mortality in pregnant women with SARS-CoV-2 infection

Overall, 4253 pregnant or recently pregnant women (169 studies, 319 172 women) with confirmed SARS-CoV-2 infection died from any cause (0.87%, 95% CI 0.64% to 1.16%). There was significant variation in rates of deaths across geographical regions (p<0.001), with studies

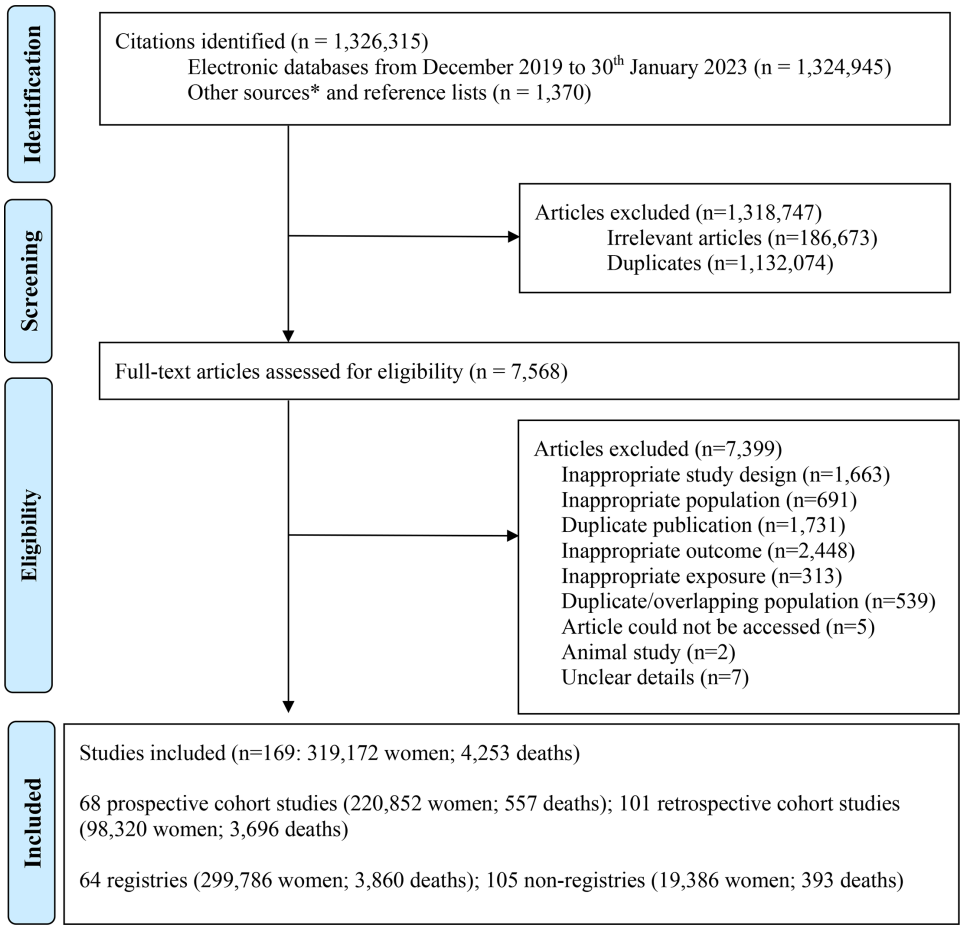

Figure 1 Study selection process in the systematic review: *Twitter, national reports, blog Thornton J, ObG Project, COVID-19 & Pregnancy Cases, https://www.obgproject.com/2020/04/07/covid-19-research-watch-with-dr-jim-thornton/; EPPI-Centre, COVID-19: a living systematic map of evidence, http://eppi.ioe.ac.uk/cms/Projects/DepartmentofHealthandSocialCare/Publishedreviews/COVID19Livingsystematicmapoftheevidence/tabid/3765/Default.aspx; Norwegian Institute of Public Health, NIPH systematic and living map on COVID-19 evidence, https://www.nornesk.no/forskningskart/NIPH_mainMap.html; John Hopkins University Center for Humanitarian Health; COVID-19, Maternal and Child Health, Nutrition, http://hopkinshumanitarianhealth.org/empower/advocacy/covid-19/covid-19-children-and-nutrition/; ResearchGate, COVID-19 research community, https://www.researchgate.net/community/COVID-19; Living Overview of the Evidence, Coronavirus disease (COVID-19), https://app.iloveevidence.com/loves/5e6fdb9669c00e4ac072701d?population=5d062d5fc80dd41e58ba8459.

from Sub-Saharan Africa reporting the highest rate of deaths (3.48%, 95% CI 0.66% to 16.42%, 4 studies; 1082 women), followed by studies from Latin America and the Caribbean (3.16%, 95% CI 1.53% to 6.43%, 16 studies; 41 227 women), South Asia (1.33%, 95% CI 0.87% to 2.04%, 55 studies; 21 491 women), the Middle East and North Africa (1.15%, 95% CI 0.57% to 2.29%, 30 studies; 4239 women), East Asia and the Pacific (0.91%, 95% CI 0.26% to 3.08%, 11 studies; 1551 women) and Europe and Central Asia (0.32%, 95% CI 0.18% to 0.57%, 42 studies; 64 229 women). The lowest rate of mortality was in North America (0.22%, 95% CI 0.07% to 0.73%, 7 studies; 182 262 women) (table 1).

Mortality rates differed significantly according to country income status (p<0.001), with the highest rates reported in low-income countries (4.66%, 95% CI 0.75% to 24.07%, 3 studies; 405 women), and lowest rates in high-income countries (0.19%, 95% CI 0.11% to 0.30%, 48 studies; 207 743 women) (table 1). The findings of individual studies are provided in online supplemental appendices 5 and 6.

Sensitivity analysis

Our sensitivity analysis when restricting to study design showed lower estimates of mortality in studies with prospective cohort design (0.70%, 95% CI 0.45% to 1.10%, 68 studies; 220 852 women) than in our main analysis of this paper. When restricted to registry data, the analysis showed higher estimates (2.00%, 95% CI 1.20% to 2.80%, 64 studies; 299 786 women). Exclusion of the largest contributing study had little impact on estimates from the main analysis (0.89%, 95% CI 0.66% to 1.19%, 168 studies; 140,834) (table 2).[17]

Causes of maternal death in women with SARS-CoV-2 infection

Of the 4253 pregnant women with confirmed SARS-CoV-2 infection who died, sufficient data were available in

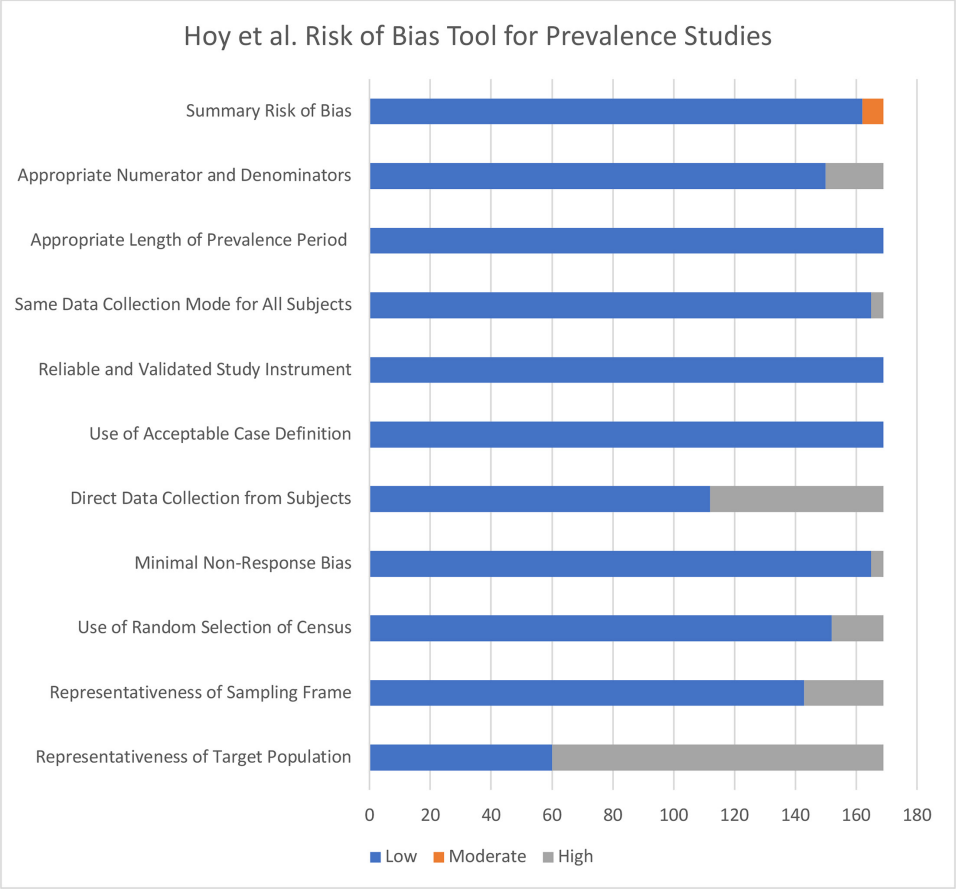

Figure 2 Risk of bias.

Table 1 All-cause mortality rates by geographical regions and country income status in pregnant and recently pregnant women with confirmed SARS-CoV-2 infection

	Number of studies	Number of maternal deaths/ number of pregnant women with SARS-CoV-2 infection	Rate (95% CI)	τ^2
Overall	169	4253/319 172	0.87 (0.64 to 1.16)	2.64
Geographic region				
East Asia and Pacific	11	23/1551	0.91 (0.26 to 3.08)	2.47
Europe and Central Asia	42	224/64 229	0.32 (0.18 to 0.57)	2.10
Latin America and Caribbean	16	3304/41 227	3.16 (1.53 to 6.43)	2.02
Middle East and North Africa	30	75/4239	1.15 (0.57 to 2.29)	1.92
North America	7	287/182 262	0.22 (0.07 to 0.73)	1.21
South Asia	55	233/21 491	1.33 (0.87 to 2.04)	1.67
Sub-Saharan Africa	4	87/1082	3.48 (0.66 to 16.42)	2.07
Multiple	4	20/3091	0.64 (0.29 to 1.40)	0.32
Income level				
Low income	3	52/405	4.66 (0.75 to 24.07)	1.85
Lower middle income	79	319/20 928	1.76 (1.27 to 2.43)	1.28
Upper middle income	35	3523/83 447	1.83 (1.08 to 3.09)	2.05
High income	48	339/207 743	0.19 (0.11 to 0.30)	0.98
Multiple	4	20/6649	0.27 (0.06 to 1.19)	1.88

Table 2 All-cause mortality rates of prospective cohort studies, registries and excluding the largest contributing study

	Number of studies	Number of maternal deaths/ number of pregnant women with SARS-CoV-2 infection	Rate (95% CI)	τ^2
Prospective cohorts	68	557/220 852	0.70 (0.45 to 1.10)	2.58
Registries	64	3860/299 786	2.00 (1.20 to 2.80)	0.00
Excluding USA CDC surveillance	168	3992/140 834	0.89 (0.66 to 1.19)	2.59

study articles or by study authors to determine the cause of death in 2423 (56.3%) of women. Most of the reported deaths in pregnant women with confirmed SARS-CoV-2 infection were assessed as being COVID-19-related (98.6%, 2390/2423), 0.4% (9/2423) were assessed as pregnancy-related and 24 deaths were coincidental and not related to either COVID-19 or the pregnancy state.

DISCUSSION

Nine out of every 1000 pregnant women with SARS-CoV-2 infection died in pregnancy or soon after, and the rates varied significantly by geographical region and country income level. The highest rates were seen in countries from Sub-Saharan Africa and in low-income countries, which already suffer the highest maternal mortality rates worldwide even before the pandemic but report low burden of SARS-CoV-2 infection.[18 19] The main cause of death in pregnant women with SARS-CoV-2 infection was due to COVID-19.

To our knowledge, this is the first study to systematically identify all reported deaths in pregnant and recently pregnant women with SARS-CoV-2 infection, investigate global differences in mortality rates and classify the causes of death using a recognised classification system. Our systematic review used a prospectively registered protocol and built on the robust living systematic review methodology and no language restrictions. Our prespecified subgroup and sensitivity analysis allowed us to explore potential sources of heterogeneity and variations in estimates. To minimise the risk of bias in our estimates, we only included studies that reported mortality outcomes on all pregnant and recently pregnant women with a confirmed diagnosis of SARS-CoV-2 infection and cared for during the study period. Our extensive deduplication process minimises the risk of including duplicate data in our analysis. To enrich the information available for our classification of causes of death, we contacted all authors to obtain additional data and strengthen our result synthesis. Our findings were limited by the paucity of reporting on the causes of death in pregnant women with SARS-CoV-2 infection. Not all authors contacted for additional data responded to our request, which made it challenging to ascertain causes of death in all women reported in our study. Despite our comprehensive search and wide study period, few studies were identified from low-income countries, or involving women in Sub-Saharan Africa. There was also wide variation in reported number of studies across geographical regions and country income groups, which may add uncertainty to our estimates.

Existing evidence on maternal mortality due to COVID-19 suggests that pregnant women are at increased risk of severe illness and death from the virus, although the exact magnitude of the risk is still not fully understood.[1] The living systematic review on maternal and perinatal outcomes of COVID-19 in pregnancy pooled data including 970 deaths and reported an all-cause mortality rate of 2 per 1000.[1] Our review includes more than 4 times as many deaths than the living systematic review with a more recent literature search, and we found a higher maternal mortality rate of nearly 9 per 1000, suggesting that deaths in pregnant and recently pregnant women with SARS-CoV-2 infection were more common than previously reported. The observed higher mortality rate than that of the living systematic review could be due to differences in study inclusion criteria, where the living review included studies of both suspected and confirmed SARS-CoV-2 cases, which may have led to an underestimation of mortality rates due to misclassification. Our methodology and data collection process were finalised prior to the emergence of variants and vaccines, so the effect of SARS-CoV-2 virus variants and vaccines on the rates of mortality still needs to be evaluated.

Evaluating spatial trends is necessary to allow for estimating the need for, and the adequate distribution of healthcare resources, including vaccines, against SARS-CoV-2.[20] Studies have shown an increase in maternal mortality during the COVID-19 pandemic compared to before, particularly in low and middle-income countries, with considerable disparities between high-resource and low-resource settings.[21 22] We found significant variation in mortality rates in low-income and countries from Sub-Saharan Africa compared with other income groups and geographical regions respectively, which are more likely to have well-established healthcare systems and implemented effective pandemic response strategies. Studies have attributed the increase in mortality for pregnant and recently pregnant women during the COVID-19 pandemic in some countries to strain on the healthcare systems, leading to disruptions in the delivery of maternal health services.[23 24] But our review identified that most deaths in women with SARS-CoV-2 infection were attributed to direct effects of COVID-19.

The differences in mortality in pregnant and recently pregnant women with SARS-CoV-2 infection across geographical regions and country income groups are likely due to several factors, including variations in healthcare access and quality, underlying comorbidities and pregnancy risk in the women, the general safety of pregnancy in the environment in which the pregnancy occurs and the severity of the COVID-19 epidemic in each region.[25] In regions with well-established and well-resourced healthcare systems, women with SARS-CoV-2 infection may be more likely to receive prompt and effective medical care due to better accessibility of treatments such as tocilizumab, Remdesivir and corticosteroids, reducing the risk of severe illness and death. Vaccines against SARS-CoV-2 may have varying accessibility based on geographical region and country income groups. In contrast, regions with more limited healthcare resources may have more difficulty providing adequate care for pregnant women with the virus, leading to higher rates of mortality. Mobility restrictions during certain periods of the pandemic, such as lockdowns, may have also limited access to care for some women and could therefore account for some of the increased deaths. Hospitals in regions with high rates of SARS-CoV-2 transmission, may have become overwhelmed, reducing the availability of medical staff and resources for women in labour and delivery. Facilities such as intensive care units and equipment such as extracorporeal membrane oxygenation may have been limited in numbers, increasing mortality. Additionally, women who had underlying health conditions, or living in poverty, may have been at higher risk of severe illness and death from the virus.

Similar to other studies reporting on cause of death in pregnant women with SARS-CoV-2, our results show that the primary cause of death in pregnant women with SARS-CoV-2 infection was directly related to COVID-19. This has important implications; first, it highlights the need for increased attention and resources to address the impact of COVID-19 on maternal health, which may include providing equitable access to COVID-19 vaccines, ensuring that maternal health services within countries are prioritised during the pandemic, and developing protocols to minimise the risk of exposure to the virus for pregnant women. Second, it emphasises the importance of early and prompt medical care for pregnant women with COVID-19. Pregnant women who experience mild to severe symptoms of SARS-CoV-2 infection should seek medical attention as soon as possible, since prompt treatment can reduce the risk of severe illness and death.[26] Some of the most effective treatments, such as tocilizumab, are not widely available and it is a key for public health campaigns to ensure improved distribution.[27 28] Finally, there is a need for ongoing research to better understand the impact of SARS-CoV-2 infection on maternal health and to develop effective strategies and interventions for preventing and treating the virus in pregnant women.

Explicit reporting of the primary causes of death (ie, COVID-19-related or pregnancy-related) with further detail on the exact cause and presentation is highly encouraged to enable robust analysis, rate calculation and quantification of the underlying reasons pregnant women with COVID-19 may die.[13] Further stratification of the mortality risk in pregnant women with SARS-CoV-2 infection by underlying comorbidities or pre-existing conditions should be calculated using a meta-analysis approach; thus identifying any differences present in their mortality risk and therefore guiding care accordingly.

The death of mothers during the COVID-19 pandemic has far-reaching implications, both for the affected families and for society as a whole, ranging from economic hardship for the family—particularly if the mother was the primary breadwinner—to reduced intergenerational transmission of values, culture and knowledge, ultimately leading to the loss of important family traditions and practices, and added strain on healthcare systems if the mothers were healthcare workers themselves.[29 30] It is important to recognise the broader social, economic and health implications of mortality in pregnant and recently pregnant women during the pandemic, so that pregnant women are encouraged to take all necessary precautions to avoid exposure to the virus, including getting vaccinated and following guidelines from public health organisations. Many countries have indeed implemented measures to protect pregnant women from exposure to the virus, such as providing access to COVID-19 vaccines and prioritising their care in hospitals. This, however, needs to be equitable across the geographical regions and country income groups.

The long-term effects of the pandemic on maternal mortality and other aspects of reproductive health are not yet known and will require ongoing monitoring and research. It is important that future research considers the impact of the evolving nature of the pandemic, the impact of different pandemic phases, including vaccination and the effects of known and emerging SARS-CoV-2 variants on global maternal mortality rates.[31 32] Additionally, the exclusion of pregnant women from experimental treatments trialled during the SARS-CoV-2 pandemic increased knowledge gaps, health disparities and suboptimal care within this group, which may have impacted mortality rates. Inclusive research that considers the specific needs of pregnant women is essential in ensuring equitable access to safe and effective treatments, improving maternal and fetal outcomes and advancing the broader understanding of COVID-19's impact on maternal health.

CONCLUSION

The overall rate of mortality in pregnant and recently pregnant women with SARS-CoV-2 infection is higher than previously reported, with significant disparities between geographical and socioeconomic regions. The primary cause of death in pregnant women with

SARS-CoV-2 infection is attributed to COVID-19 infection.

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Contributors ST, MB and JA conceptualised the study. MY, YK, KB, GM, IS-E, AKhashaba, DZ, MM, JS, HL, TK, KA, SA, ML, HF, TR, AG, AD, DA and AB selected the studies. JA, SF-G, GR-C, MRR, MY, YK, KB, AKhashaba, DZ, HK, MK, MH and MM extracted the data. JZ, KB, MM and SF-G conducted the analyses. All co-authors contributed to the writing of the manuscript and approved the final version. ST, JA and JZ are the guarantors. The corresponding author attests that all listed authors meet authorship criteria.

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