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Maternal mortality in Colombia during the COVID-19 pandemic: time series and social inequities

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ABSTRACT

Objective The impact of the COVID-19 pandemic goes beyond morbidity and mortality from that disease. Increases in maternal mortality have also been described but have not been extensively studied to date. This study aimed to examine changes in maternal mortality and identify correlates and predictors of excess maternal mortality in Colombia during the pandemic.

Setting Analysis of data from the national epidemiological surveillance databases of Colombia (Sivigila).

Participants Deaths among 6342 Colombian pregnant women who experienced complications associated with pregnancy, childbirth or the perperium during 2008–2020 were included in this study. For inequalities analysis, a subsample of 1055 women from this group who died in 2019 or 2020 years were analysed.

Methods We collected data from the national surveillance system (Sivigila) on maternal mortality. Analysis was carried out in two stages, starting with a time series modelling using the Box-Jenkins approach. Data from Sivigila for 2008–2019 were used to establish a baseline of expected mortality levels. Both simple and complex inequality metrics, with the maternal mortality ratios (MMRs), were then calculated using the Multidimensional Poverty Index as a socioeconomic proxy.

Results Maternal deaths in 2020 were 12.6% (95% CI −21.4% to 95.7%) higher than expected. These excess deaths were statistically significant in elevation for the months of July (97.4%, 95% CI 35.1% to 250.0%) and August (87.8%, 95% CI 30.5% to 220.8%). The MMR was nearly three times higher in the poorest municipalities compared with the most affluent communities in 2020.

Conclusions The COVID-19 pandemic had considerable impact on maternal health, not only by leading to increased deaths, but also by increasing social health inequity. Barriers to access and usage of essential health services are a challenge to achieving health-related Sustainable Development Goals.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study's main strength was to apply a combination of quantitative methods from official epidemiological surveillance databases to generate evidence about the impact that COVID-19 had on maternal mortality in Colombia.
⇒ This study further generated evidence about social health inequities among pregnant women in Colombia, in the context of the COVID-19 pandemic.
⇒ This is an ecological study, for which individual measurements are not carried out and therefore direct causality cannot be inferred.
⇒ Analysis was not disaggregated to Colombian jurisdictions, thus likely under-representing the level of local variations in the results.

INTRODUCTION

The impact of the COVID-19 pandemic among pregnant women and their newborns, has not been extensively examined to date.[1] Some reports show an increase in maternal mortality during the pandemic.[2 3] In addition, some studies on mortality in pregnant women with COVID-19 have shown a higher risk of death among those with lower income and poorer living conditions.[4 5] Does this result from infection, poorer access to health services or other factors? Previous research on gender-based violence, congenital syphilis,[6] cardiovascular disease, diabetes and tuberculosis suggests that marginalisation and poverty increase health risks related to COVID-19 pandemic.[7 8]

In Colombia, a study of health disparities in the COVID-19 mortality found that the risk of dying from COVID-19 is higher for indigenous people, those with public subsidised health insurance, and those from the lowest income group.[9] Several studies have addressed pregnancy complications and clinical care guidelines for pregnant women.[10 11]

To date, however, there had not been an analysis of excess maternal mortality and related social inequities during COVID-19 pandemic. For this reason, the objective of this analysis was to examine the impact of the pandemic on maternal mortality and its implications for social inequities in Colombia.

METHODS

A descriptive and retrospective analysis was carried out implementing two methodologies: a time series analysis and the measurement

of both simple and complex inequalities. Official data source was the Colombian epidemiological surveillance system (Sivigila, by its Spanish acronym), including maternal deaths registers reported during period 2008–2020 to Sivigila. The response variable was the maternal mortality cases and ratios in Colombian women and the covariate used to measure inequality corresponded to the municipality of residence of the pregnant woman classified according to the Multidimensional Poverty Indices (MPIs) for the country. The Sivigila collects information on events of interest in public health, including maternal mortality, with coverage in every municipality.[12] Despite errors in capturing information at the local level,[13] the National Institute of Health has strengthened the quality, timeliness and comprehensiveness of the data.[14] During the pandemic, surveillance system has kept track of the maternal mortality.

For time series analysis the Box-Jenkins approach[15 16] was implemented to identify changes in the number of maternal deaths in 2020 compared with expected deaths using national surveillance data for 2008–2019 as a baseline. Next, we created both simple and complex inequality measures for 2019 and 2020.[17] Simple inequities metrics included absolute, relative and population attributable fraction (PAF). The PAF is a metric that approximate the proportion of maternal mortality that would be reduced if all pregnant women lived in places with the best socioeconomic conditions. The complex measurements included Slope Inequality Index (SII) and Relative Inequality Index (RII). Both are weighted linear regressions that quantify the absolute and relative change, respectively, of the maternal mortality ratios (MMRs) comparing lowest and highest social positions in the population and use MPI from the National Institute of Statistics (*Departamento Administrativo Nacional de Estadística-DANE*).[18]

MPI consists of five dimensions of poverty: household education levels, children and youth conditions, work, health and public services access, evaluated by 15 questions. MPI provides a cut-off to classify a home as multidimensionally poor when it meets the criteria for at least 5 of the 15 items. The MPI provides a cut-off point of 20% of the live births in each quintile to classify a household as multidimensionally poor when it meets the criteria for at las 5 of the 15 elements.

Patient and public involvement

As this research is based on a secondary data review, there was no patient or public involvement in the conceptualisation or operationalisation of the research.

Data and data adjustments

Maternal mortality is defined as the death of a woman while pregnant or within 42 days after the termination of pregnancy. Late maternal deaths are those that occur after 42 days, but within 1 year of termination of pregnancy.[19] The total number of maternal deaths also include coincident cases (ie, road traffic or violence deaths while pregnant). For the time series analysis, 2008–2020 maternal mortality surveillance data was drawn from Sivigila.[12] For the inequities analysis data for 2019 and 2020 was used, but for these 2 years the Sivigila only reported information on early maternal deaths. For prior years, the surveillance system reported all maternal deaths: early, late and coincident.[20 21] A proportional adjustment projection estimate by epidemiological week and municipality was used for 2019 and 2020 to estimate total maternal deaths based on the relationship of early to total maternal deaths for prior years.[20 21]

Time series analysis

For time series estimates data were grouped by month. Verification of data dependence using L-Jung Box and Box-Pierce tests showed that this was successful as no outliers were found. Verification of seasonality was carried out using the Kruskall-Wallis and Friedman tests, to verify whether they corresponded to seasonal (Seasonal Autoregressive Integrated Moving Average) or non-seasonal (Autoregressive Integrated Moving Average (ARIMA)) models (details in online supplemental material). Forecasting of the model was based on data for 2008–2019. The best model for the 12 months of 2020 was chosen using Akaike criterion, white noise and normality tests in the residuals as the L-Jung Box and Jarque-Bera tests. A graphical comparison was done showing both the original data series and the adjusted model.

A percentage change in the number of deaths was calculated for the period of the pandemic. The percentage change in reported cases by month was examined for the entire period analysed. The information was represented in double-axis graphs with the number of cases that occurred per month and the estimated cases with 95% CIs, defined as:

$$\text{Percentage change } \% = \frac{\text{number of observed cases} - \text{number of estimated cases}}{\text{number of estimated cases}} \times 100$$

Social inequities analysis

Annual MMRs were calculated by groups of municipalities, sorted by MPI, as a ratio of the total number of maternal deaths compared with the number of live births notified to DANE for each year. The municipalities were grouped by population quintiles of MPI. Each quintile is equivalent to an accumulated 20% of the population (according to data from the 2018 census), with quintile one (Q1) being the most affluent and the last quintile (Q5) being the poorest. Relative and absolute gaps were measured between the population of the quintiles of the MPI for 2019 and 2020.

To calculate the PAF of excess mortality due to economic status, average MMR were compared with those in the highest quintile:

$$\text{PAF} = \frac{\text{MMR}_{\text{average}} - \text{MMR}_{\text{Q1}}}{\text{MMR}_{\text{average}}} \times 100$$

The calculation of complex inequities metrics was carried out by calculating the SII, by a weighted linear regression

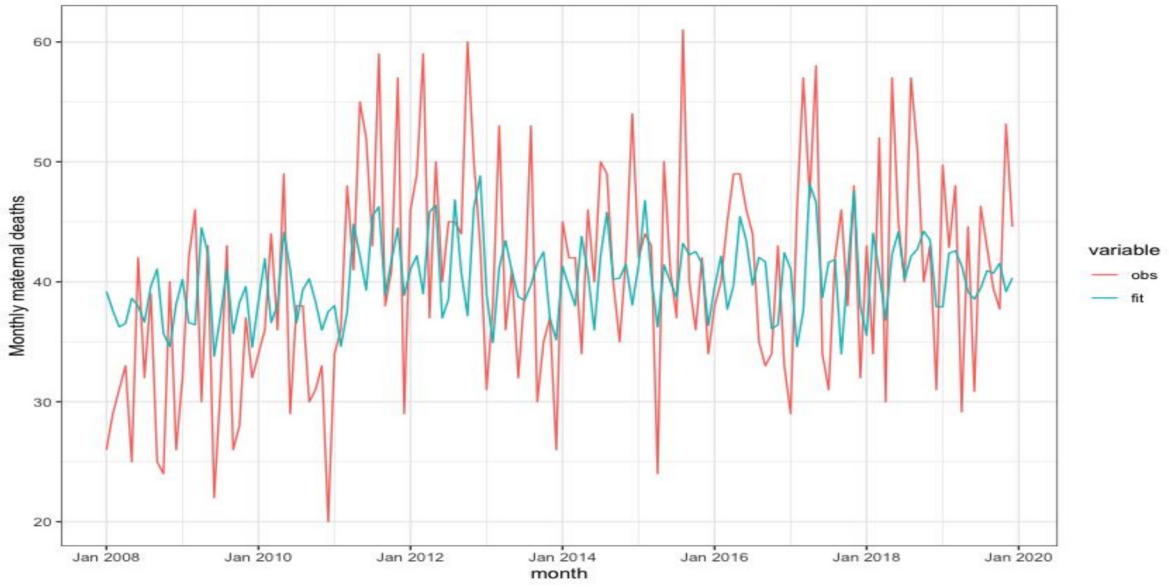

Figure 1 Comparison of original data series and Autoregressive Integrated Moving Average modelling, Colombia 2008–2019.

(details in online supplemental material). The health indicator (MMR) was estimated by quintile groups of municipalities according to MPI levels. We calculated relative and cumulative frequencies, and the ridit which corresponds to the average accumulated frequency.[17 22 23] After having the results of the SII, the RII was estimated according to the equation proposed by Kunst y Mackenbach.[24]

For inequities monitoring, the magnitude of change of the MMR for each inequality indicator (absolute, relative, SII and RII) was calculated based on equations proposed by Bacallao.[25] The magnitude of change measure was calculated giving a bigger weight to the gap reduction than the variation in MMR[25] (details in online supplemental material). A positive result of this measure would be a reduction in the gap between municipalities of higher and lower socioeconomic status. A negative result would indicate a rising gap between these municipalities. The RECORD checklist criteria were met (see online supplemental material).

RESULTS

A total of 6342 deaths among pregnant women in Colombia during 2008–2020 as a result of complications associated with pregnancy, childbirth or the puerperium

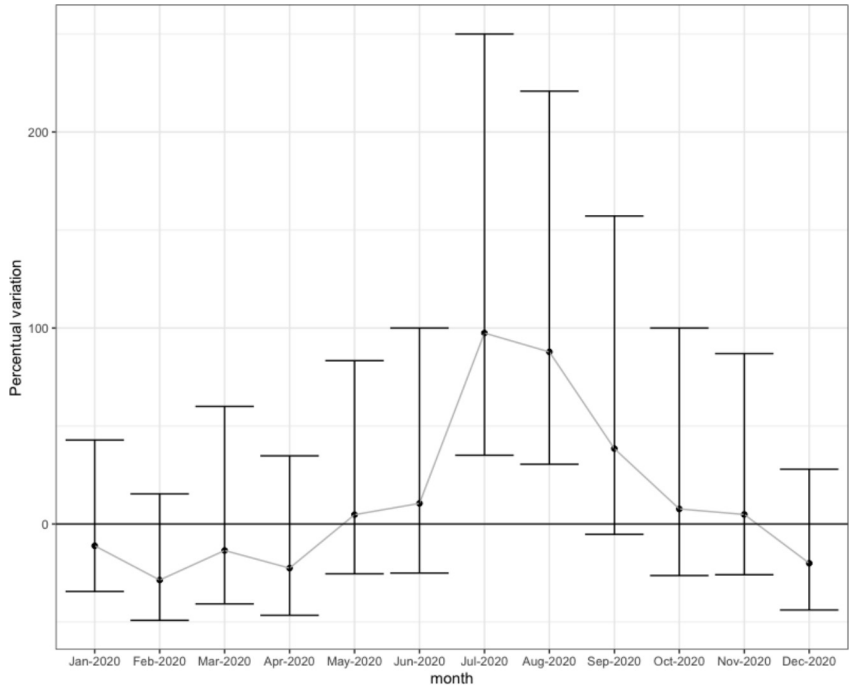

Figure 2 Percentage variation between observed cases and projected cases with Autoregressive Integrated Moving Average modelling, Colombia, 2020.

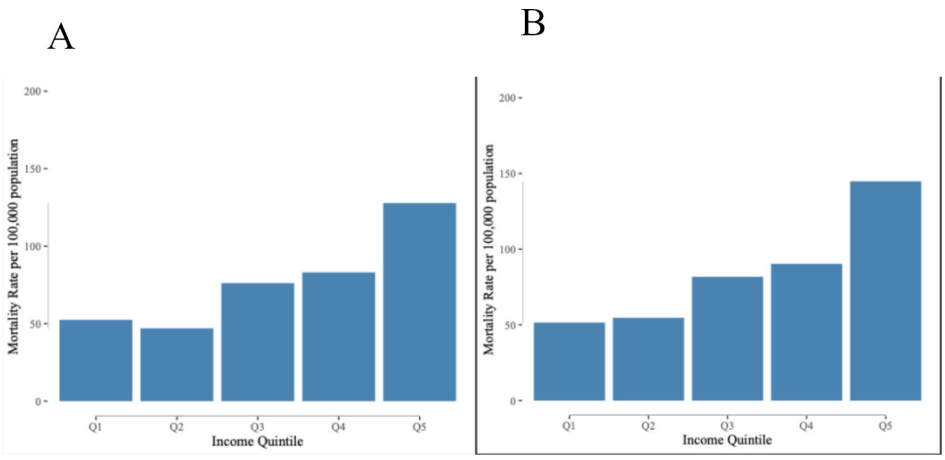

Figure 3 Maternal mortality ratio by quintiles in Colombia, 2019–2020.

were reported to Sivigila. In 2019, the prepandemic year, Colombia reported 511 maternal deaths with an MMR of 80 maternal deaths per 100 000 live births, according to the National Surveillance System. The time series model estimated 483 deaths expected for 2020 considering the behaviour of 2019, however, 544 early and late maternal deaths were recorded (MMR of 87 per 100 000 live births). This represents an excess death rate of 12.6% (95% CI −21.4% to 95.7%) of deaths. The time series ARIMA analysis showed that the six parameters were statistically significant, and their residuals were normally distributed (online supplemental table S1). Comparison of the original data series and modelled series is found in figure 1.

Excess maternal deaths in Colombia for 2020 were highest in July and August; these were the only months when excess deaths were statistically significant (97.4%, 95% CI 35.1% to 250.0% and August 87.8%, 95% CI 30.5% to 220.8%) (figure 2).

For the years under study, mortality rates were highest in municipalities with the lowest social quintile scores (figure 3). An increase in rates for 2020 was identified for the absolute, relative and PAF metrics (table 1). The rate of maternal deaths was almost three times higher in the lowest quintile municipalities compared with the highest quintile municipalities (table 1).

Regarding complex inequities metrics, for 2020 there was also an increase. According to the SII for this year, in the worst poverty quintile there were 138 additional maternal deaths for every 100 000 live births. According to the RII, maternal mortality was 3.5 times higher in the worst condition quintile. In both years the R^2 value of the inequality regression models exceeded 80%, which indicates a strong correlation between MMR and socioeconomic vulnerability. The gap in maternal death rates was even higher in 2020 than in 2019 (table 1).

DISCUSSION

The COVID-19 pandemic was associated with a rise in maternal deaths in Colombia. This rise was greatest in municipalities with the lowest wealth quintile, and the gap in mortality rates between high and low quintile municipalities also rose. We found an excess of maternal mortality of 12.6% (95% CI −21.4% to 95.7%) in 2020, but with statistical significance only for the months of July and August (97.4%, 95% CI 35.1% to 250.0% and 87.8%, 95% CI 30.5% to 220.8%, respectively). Statistical significance of the results for July and August may reflect heightened transmission during the first peak of the pandemic.[19 26] Historical data does not suggest a higher MMR during those months.

These results are consistent with those reported elsewhere, where not only maternal deaths, but also maternal and neonatal morbidity suffered, and rising inequality

Table 1 Estimation of simple and complex inequality measures for maternal mortality 2019–2020 in Colombia

Inequality metric	Year		Monitoring
	2019	2020	
Absolute	75.4	93.3	−57.06
Relative	2.4	2.81	−39.81
Population attributable fraction	46.4%	65.7%	−58.12
Slope Inequality Index (95% CI) R^2	−53.7 (−157.4 to −26.8) 0.87	−138.0 (−161.3 to −36.1) 0.85	−109.15
Relative Inequality Index	3.7	3.6	−2.96

gaps occurred during the pandemic.[27–30] This may reflect socioeconomic disadvantage,[31] poorer access to basic services and barriers to access to healthcare.[32 33] In Colombia rural and indigenous women, those with subsidised health insurance, those with low incomes and those with low educational achievement have historically had higher maternal mortality rates.[20]

In Colombia, poorer access to health services due to pandemic-related closures and redirection of services likely reduced access to timely care for pregnant women,[34] leading to an increase in fatal outcomes.[35–37] Lockdowns also may have worsened the basic living conditions of the most vulnerable women. For example, transportation limitations due to mobility restrictions may have delayed the timely use of health services by pregnant women in remote areas. Cultural reasons, beliefs, and the same fear of contagion in health facilities may also have made pregnant women more hesitant to use services, as observed for other health concerns.[3 34 37]

The importance of closures, transportation changes and popular fears regarding the use of existing services have important policy implications for future emergencies. Closures and redirection of services can be carried out in ways that favour vulnerable populations better. Publicity about transportation networks can reassure people that planning is done with them in mind. Education and health promotion can emphasise the importance of basic services, helping to balance the fear of non-use with existing fears regarding the use of services. When risks increase, people need ongoing orientation to manage competing needs better.[38–41] All this can be considered in response plans now to support health and reduce inequities in the future.

This study has limitations. First, as an ecological analysis, direct causality cannot be inferred from population level data. Second, analysis was not disaggregated to individual Colombian departments or municipalities and thus local variations in results are not captured. Third, there was no testing or adjustment for the quality of Sivigila data. These data are considered to be of good overall quality and to have improved in recent years.[13] Sivigila complies with the standards of the Web-Based Maternal Mortality Epidemiological Surveillance System,[42] to assess under registration and data is carefully compared with National Administrative Department of Statistics (DANE)[43] software that verify the WHO recommendations to reduce the under-registration of maternal deaths. In Colombia, Sivigila information has also been widely used to calculate health inequities, among other analysis.[9 44] Finally, the results from this study in Colombia may not be generalised to those in countries with different cultural and economic systems and health service characteristics.

CONCLUSION

This study tracked maternal mortality trends during the first year of COVID-19 pandemic in Colombia. We identified both an increase in maternal deaths and a widening of inequity in deaths by socioeconomic level. The study highlights the need to monitor and proactively respond to known inequities that generate avoidable deaths. Maternal mortality is a key public health indicator for social development and equity in a society. Further monitoring during this and future disease outbreaks can be used to reduce inequities and improve health outcomes.

The pandemic, appears associated with a delay in achieving the 2030 UN's Sustainable Development Goals (2030), related to health, well-being and reduction of maternal mortality. The 509 municipalities located in the poorest quintile in Colombia are not likely to reach the goal of reducing maternal mortality below 70 deaths per 100 000 live births. Although these municipalities are culturally and geographically heterogeneous, they share basic deficiencies in education, healthcare and access to basic services. We are challenged to overcome this reversal.[6 27]

Contributors CC-O participated in conceptualisation, data analysis, writing and data validation, and is the guarantor of overall content. LHG participated in conceptualisation, data analysis, writing and editing. DD-J participated in methodology development, data validation, writing and editing. KC-C participated in writing, editing and data validation. RG participated in writing, editing and data validation.

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