Maternal mortality disparities in India

Sangita Vyas[*], Payal Hathi[†], Aashish Gupta[‡]

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Abstract

The world is unlikely to meet the 2030 Sustainable Development Goal for maternal mortality, in part due to large and growing disparities in maternal mortality within countries. Maternal mortality disparities have been difficult to study in low- and middle-income country (LMIC) contexts, where most maternal deaths occur, due to underdeveloped vital registration systems. Using Demographic and Health Survey data, this study is the first to quantify inequalities in maternal mortality across social group, economic status, and urban versus rural residence in India, a country with deep social inequalities and the largest population in the world. The Indian DHS includes a module that asks respondents to report on recent deaths in the household. We use this module to estimate maternal mortality. Relative to high-caste Hindus, maternal mortality among Scheduled Castes and Scheduled Tribes is more than double, and among Muslims and Other Backward Classes is approximately 1.5 times larger. Maternal mortality among the poorest women is almost 2.5 times that among the richest women. Rural women's maternal mortality is about 1.5 times higher than that of urban women. The relative disparities are similar in magnitude to the Black-White maternal mortality gap in the United States, but absolute disparities in India are more than four times larger because overall maternal mortality is higher. This analysis advances empirical methods for estimating maternal mortality in LMICs using high-quality, nationally-representative household survey data. Findings underscore the global imperative to address maternal health disparities rooted in social inequalities within, in addition to across, populations.

[*]Hunter College and CUNY Institute for Demographic Research, at the City University of New York; Population Wellbeing Institute at the University of Texas at Austin; and r.i.c.e. sangita.vyas@hunter.cuny.edu.

[†]University of California, Berkeley; and r.i.c.e. phathi@berkeley.edu.

[‡]University of Oxford; and r.i.c.e. aashish.gupta@sociology.ox.ac.uk.

1 Introduction

Maternal death can have devastating consequences for surviving family members, and is a failure of society as a whole. The Sustainable Development Goals (SDG) call for reducing the global maternal mortality ratio (MMR) to fewer than 70 maternal deaths per 100,000 live births by 2030. However, a recent report by the United Nations (UN) and World Health Organization (WHO) finds that global progress towards meeting this goal has stalled, partially as a result of the disruptions caused by COVID-19 (Organization et al., 2023). The world is not on track to meet the 2030 SDG for maternal mortality (Menendez et al., 2023). Halted declines and reversals have even been evident in high-income countries (HICs). For example, MMR in the United States has almost doubled between 2018 and 2021, and gaps between Blacks and Whites have widened substantially (Hoyert, 2023). Given such setbacks and slow progress, understanding disparities in maternal mortality within populations can inform improvements in health policy.

In HICs, studies of disparities in maternal mortality are made possible by complete vital registration systems, and strong health surveillance systems that track and classify pregnancy-related deaths. The study of maternal mortality trends and inequalities in low- and middle-income countries (LMICs), however, is complicated by the absence of complete vital registration and the lack of suitable datasets measuring maternal deaths and socio-economic characteristics. This paper focuses on maternal mortality disparities in India, the most populous country in the world, which the UN and WHO estimate to have the second highest number of maternal deaths globally (Organization et al., 2023).

India is a highly unequal society. Dalits, Adivasis, Muslims, and Other Backward Classes are marginalized in Indian society based on caste, indigenous identity, and religion, and they face substantial health and mortality disadvantages relative to high-caste Hindus, who are comparatively privileged (Vyas, Hathi and Gupta, 2022; Gupta and Sudharsanan, 2022). These groups combined represent a population of over 200 million women, greater than the population of women in the United States. Large and persistent health inequalities have also

been documented by economic status (Vyas, Hathi and Gupta, 2022; Gupta, 2021; Barik, Desai and Vanneman, 2018; Asaria et al., 2019), and urban versus rural residence (Saikia et al., 2013; Gupta, 2021).

This paper is the first to describe disparities in maternal mortality by social group, economic status, and geography in India. We overcome data constraints by using India's National Family Health Survey (NFHS), a high-quality nationally-representative household survey that collected information on recent household deaths, as well as socio-economic characteristics. Maternal mortality is, even in India, a rare event. For statistical power, we combine data from the two most recent NFHS, carried out in 2015-2016 and 2019-2021, respectively. Official maternal mortality estimates for India produced by the Government of India rely on the Sample Registration System (SRS), which does not disaggregate data by social group, economic status, or urban versus rural residence. SRS microdata are also not publicly available. For these reasons, the SRS cannot be used to estimate maternal mortality by socio-economic characteristics.

We follow the WHO definition for maternal mortality and classify maternal deaths based on whether a woman of reproductive age was reported to have died during or shortly after pregnancy or child birth. This system produces a distribution of maternal deaths across ages that is very similar to that in India's SRS (see Table 1). All-cause age-specific mortality rates and age-specific fertility rates are also similar between the NFHS, SRS, and UN life-tables (see Appendix Figures A1 and A2). These analyses signal high data quality in the NFHS.

We find very large disparities along all dimensions of socio-economic status. Relative to high-caste Hindus, the MMR is more than double among Scheduled Castes and Scheduled Tribes, and is more than 1.5 times larger among Muslims and Other Backward Classes. The gradient by economic status is very steep, with MMR among women in the poorest quartile almost 2.5 times that among women in the richest quartile. By geography, the MMR for rural women is about 1.5 times higher than the MMR for urban women. In relative terms, these disparities are similar in magnitude to those observed in the US, where MMR among

Blacks was about 2.6 times that among Whites in 2021. However, the gaps are much larger in absolute terms because overall levels are much higher in India.

This analysis makes several contributions to the literature on social disadvantage and maternal health in LMICs. First, these estimates fill an important gap in scientific understanding of patterns of maternal mortality in India, and globally. Second, our approach advances methods for using household survey data for maternal mortality estimation in LMICs (Graham et al., 2004; Hill et al., 2006; Franz et al., 2022). From a policy perspective, this study highlights the importance of addressing health inequalities based on caste, indigenous identity, religion, wealth, and geography.

2 Data and methods

Data for this project are from the publicly-available National Family Health Surveys (NFHS), which are India's Demographic and Health Surveys (DHS). The DHS is an international program which collects high-quality, nationally-representative population health data using repeated cross-sectional surveys in over 90 LMICs in the world. This project uses data from the two most recent NFHS: NFHS-4 (2015-2016) and NFHS-5 (2019-2021). Because maternal deaths are relatively rare events, we pool data from the two surveys to study disparities across groups.

2.1 Estimating the Maternal Mortality Ratio

This study examines inequalities in the maternal mortality ratio (MMR), which is a ratio of maternal deaths to live births. The two parts of the MMR are estimated from two separate modules of the NFHS. The household questionnaire of the NFHS is used to estimate maternal deaths and the women's questionnaire is used to estimate births.

The household questionnaire asked the respondent to report the demographic information of all usual members of the household. This module then asked the respondent whether any

usual members of the household had died in the three to four years prior to the survey. For each deceased person, the month and year of death and age at death were collected. The survey also asked follow-up questions that can be used to identify maternal deaths. If a death occurred to a female age 12 or older, the respondent was asked whether the woman died during pregnancy, childbirth, or within two months after the end of pregnancy or childbirth. Maternal deaths are those for which the respondent answered "yes" to this question, and for which the woman who died was between the ages of 15-49.

The women's questionnaire is used to estimate births. The NFHS interviewed all women in the household between the ages of 15-49, and asked each woman details about all live births. In order to have a consistent reference period for maternal deaths and births, we include births during the same look-back period as that used for the household deaths question. Because maternal deaths and live births are estimated from two different questionnaires in the survey, and were often collected from different respondents, we scale both maternal deaths and births by the person-years lived by women age 15-49 estimated from each of the questionnaires. Scaling in this way avoids problems that might arise from inconsistencies across questionnaires.

Using this information, the MMR can be estimated as:

$$MMR = \frac{\frac{maternal\ deaths\ to\ women\ age\ 15-49}{person-years\ lived\ by\ women\ age\ 15-49\ from\ household\ questionnaire}}{\frac{births\ to\ women\ age\ 15-49}{person-years\ lived\ by\ women\ age\ 15-49\ from\ women's\ questionnaire}} \times 100,000. \quad (1)$$

Observations are weighted using the household and woman weights, respectively, provided in the survey. To examine disparities in maternal mortality, we estimate the MMR separately by rural versus urban residence, wealth quintile, and caste and religious groups.

2.2 Inference for MMR

Standard errors are estimated using the cluster-boostrap method described in Cameron and Miller (2015), a method which applies in this setting because the NFHS randomly sampled

primary sampling units (PSUs) rather than individuals, and both outcomes and explanatory variables are likely correlated within PSUs.

Within districts, the NFHS randomly sampled PSUs stratified by rural and urban classification, population size, and Scheduled Caste and Scheduled Tribe representation. About 22 households were sampled within each PSU. For the bootstrap, we resample with replacement N_s PSUs within each stratum, with N_s equal to the total number of PSUs in that stratum in the original NFHS sample. We estimate the MMR using the dataset generated by each resample. We repeat this process 500 times, and the standard deviation of the 500 resulting estimates for each statistic are used for calculating 95% confidence intervals.

2.3 Mortality and fertility in the NFHS and other sources

Figure 1 displays age-specific maternal mortality rates, computed as deaths per 100,000 person-years, and fertility rates, the two values used for computing the numerator and denominator, respectively, of the maternal mortality ratio, as described in Equation 1. In India, both maternal mortality and fertility are highly concentrated in the 20 to 29 age group. The overall risk of a woman dying a maternal death is higher in this age range, but this is largely because fertility is higher during this age range as well. For this reason, it is relevant to consider the MMR, which characterizes the risk of death in terms of live births.

Table 1 shows the distribution of maternal deaths across age groups in the NFHS and the Sample Registration System (SRS). The total number of maternal deaths observed in both the NFHS 4 and 5 is 957. The underlying count of deaths is not made available in SRS Maternal Mortality Bulletins. The NFHS shows a slightly lower proportion of deaths in the 25-29 age group relative to the SRS. However, both sources show that about two-thirds of maternal deaths occur in the 20-29 age group. Both sources also show that the proportion of deaths below age 20, and at age 35 and above, are small.

We also compare all-cause female mortality and fertility rates from the NFHS to the SRS and the United Nations World Population Prospects (WPP). Appendix Figures A1

and A2 show these comparisons. Mortality rates between the NFHS, SRS, and WPP are on the whole similar. The NFHS shows slightly higher mortality in the 15-19, 20-24, and 25-29 age groups relative to the other data sources, but mortality in these ages is very low, and absolute differences are small. The NFHS also shows a slightly younger age-profile of fertility, and a slightly lower total fertility rate, relative to the SRS and WPP. However, the overall fertility patterns are similar across data sources.

3 Results

Is maternal mortality higher among socially disadvantaged groups in India, such as Scheduled Castes, Scheduled Tribes, Muslims, Other Backward Classes? Figure 2 shows that maternal mortality closely mirrors other patterns of social disadvantage in Indian society. Scheduled Castes and Scheduled Tribes, the most marginalized social groups in Indian society, had the highest levels of maternal mortality in 2013-2020, of 294 maternal deaths per 100,000 live births among SCs, and 320 maternal deaths per 100,000 live births among STs. The level of maternal mortality observed among SCs and STs is twice the level observed among high-caste Hindus, the social group that is most privileged in Indian society. Maternal mortality is substantially higher than high-caste Hindus among other marginalized groups such as OBCs and Muslims also. The Maternal Mortality Ratio among these groups was about 1.7 times higher compared to High-caste Hindus.

Figure 3 examines the extent to which maternal mortality is lower among the rich when compared to the poor. We construct a wealth index as a principle component of the household goods and assets that a household owns, as is standard in the literature. In constructing the wealth index, we ignore assets with a direct link to mortality, such as solid fuel use or toilet ownership. Figure 3 shows that the maternal mortality among the poorest quartile has comparatively much higher maternal mortality than the other three wealth quartiles. Maternal mortality in the poorest quartile is close to 400 deaths per 100,000 births, nearly

2.5 times the maternal mortality observed in the richest quartile. Maternal mortality in the second and third quartiles is also higher - about 1.4 and 1.3 times the richest quartile, respectively.

Figure 4 shows that maternal mortality is higher in rural areas compared to urban areas. We observe a maternal mortality ratio of 283 maternal deaths per 100,000 live births in rural areas, about 1.5 times the maternal mortality ratio observed in urban areas.

4 Discussion

Using an innovative empirical approach with data from an LMIC setting, this article is the first to document large disparities in maternal mortality in India, the most populous country in the world. We show that maternal mortality among marginalized social groups belonging to Scheduled Castes and Scheduled Tribes was twice that among high-caste Hindus, who are privileged in Indian society. Even more drastically, among the poorest wealth quartile, maternal mortality was 2.5 times that among the richest wealth quartile.

Why are maternal mortality disparities so stark in India? We observe only a limited set of characteristics for deceased individuals in the NFHS surveys, and are unable to account for the extent to which factors such as access to healthcare, maternal health, or discrimination in healthcare settings contribute to these disparities. This is an important avenue for future research and data collection efforts. Based on available information in surveys such as the NFHS, we can make some conjectures.

Could higher parity births or later childbearing be contributing to the observed social group differences in maternal mortality? These factors may play a role in helping to explain differences across economic status, since fertility is higher among poorer households than richer households. However, these may not play a big role in explaining differences across caste groups. In NFHS-5, period fertility rates for the three years preceding the survey were 2.08 and 2.09 births per woman for Scheduled Castes and Scheduled Tribes respectively, just

marginally higher than the all-India period TFR of 1.99.

Disparities in maternal and child healthcare access may also play a role in explaining maternal mortality gaps. For instance, 72% of mothers from the lowest wealth quintile received ante-natal care from a skilled provider, while 94% of mothers from the highest wealth quintile received antenatal care from a skilled provider. Only about 42% of pregnancies to women from the lowest wealth quintile were preceded by four or more ANC visits, which is the official government recommendation, compared to 72% for women from the highest wealth quintile. Similarly, 76% of deliveries in the lowest wealth quintile were in a health facility, in contrast to 97% in the highest quintile. Differences in healthcare access are starker along lines of class than caste: for instance, compared to 88.6% of all births that were in a health facility, 87.3% of births among Scheduled Castes and 82.3% births among Scheduled Tribes were in a health facility. Access to healthcare may thus help explain why we see particularly high maternal mortality among the poorest households, substantially higher than maternal mortality among the most marginalized castes[1] Access to healthcare is also lower among Scheduled Tribes compared to Scheduled Castes, consistent with slightly higher maternal mortality among STs when compared to SCs. On the whole, disparities in healthcare may contribute to maternal mortality disparities.

In terms of women's health in the reproductive ages, we observe disparities in anemia prevalence and BMI. 64% of women in the lowest wealth quartile had any anemia, compared to 51% among the richest quartile of women. Disparities in BMI are even starker: women from the lowest quintile are 2.8 times more likely to have BMI less than 18.5 than women from the richest quintile.

5 Before PAA

Before PAA, we plan to:

[1] CIs for maternal mortality among Scheduled Castes and the poorest quartile do not overlap.

- Investigate maternal mortality disparities using data from NFHS-1 and NFHS-2, which were conducted in 1992-93 and 1998-2000, respectively. This will help us understand trends in disparities, in a period where access to maternal and child health has increased.

- Document maternal mortality disparities using the Annual Health Survey which is a larger survey conducted in 9 of the poorest Indian states in 2007-2009

- Examine the extent to which differences in economic status and age-specific fertility rates can explain the social group disparities that we observe

References

Asaria, Miqdad, Sumit Mazumdar, Samik Chowdhury, Papiya Mazumdar, Abhiroop Mukhopadhyay, and Indrani Gupta. 2019. "Socioeconomic inequality in life expectancy in India." *BMJ Global Health*, 4(3): e001445.

Barik, Debasis, Sonalde Desai, and Reeve Vanneman. 2018. "Economic status and adult mortality in India: Is the relationship sensitive to choice of indicators?" *World development*, 103: 176–187.

Cameron, A Colin, and Douglas L Miller. 2015. "A practitioner's guide to cluster-robust inference." *Journal of Human Resources*, 50(2): 317–372.

Franz, Nathan, Aashish Gupta, Dean Spears, and Diane Coffey. 2022. "Uncertainty about maternal mortality in India: New, higher estimates from the National Family Health Survey-4."

Graham, Wendy J, Ann E Fitzmaurice, Jacqueline S Bell, and John A Cairns. 2004. "The familial technique for linking maternal death with poverty." *The Lancet*, 363(9402): 23–27.

Gupta, Aashish. 2021. "Health, Environment, and Inequality in India." PhD diss. University of Pennsylvania.

Gupta, Aashish, and Nikkil Sudharsanan. 2022. "Large and Persistent Life Expectancy Disparities between India's Social Groups." *Population and Development Review*.

Hill, Kenneth, Shams El Arifeen, Michael Koenig, Ahmed Al-Sabir, Kanta Jamil, and Han Raggers. 2006. "How should we measure maternal mortality in the developing world? A comparison of household deaths and sibling history approaches." *Bulletin of the World Health Organization*, 84(3): 173–180.

Hoyert, Donna L. 2023. "Maternal mortality rates in the United States, 2021." *NCHS Health E-Stats*.

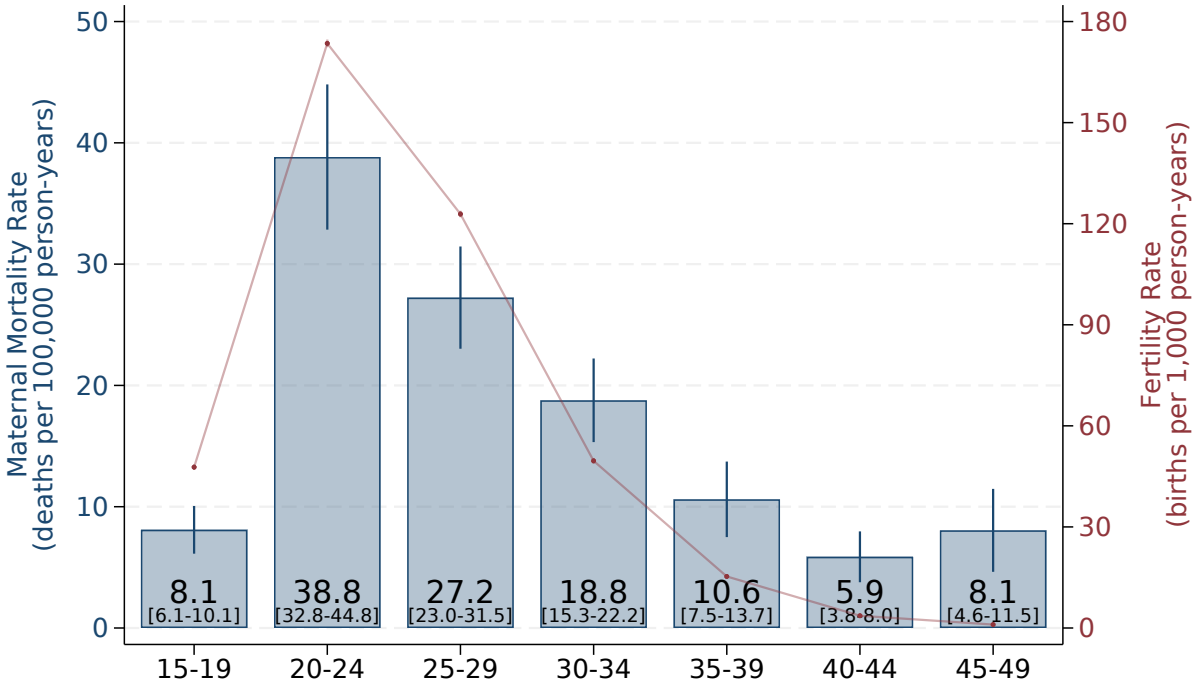
Menendez, Clara, Tacilta Nhampossa, Diane Fifonsi Gbeasor-Komlanvi, Valentina Buj de Lauwerier, Gagan Gupta, and Flavia Bustreo. 2023. "Stalled global progress on preventable maternal deaths needs renewed focus and action."

Organization, World Health, et al. 2023. *Improving maternal and newborn health and survival and reducing stillbirth: progress report 2023.* World Health Organization.

Saikia, Nandita, Abhishek Singh, Domantas Jasilionis, and Faujdar Ram. 2013. "Explaining the rural–urban gap in infant mortality in India." *Demographic Research*, 29: 473–506.

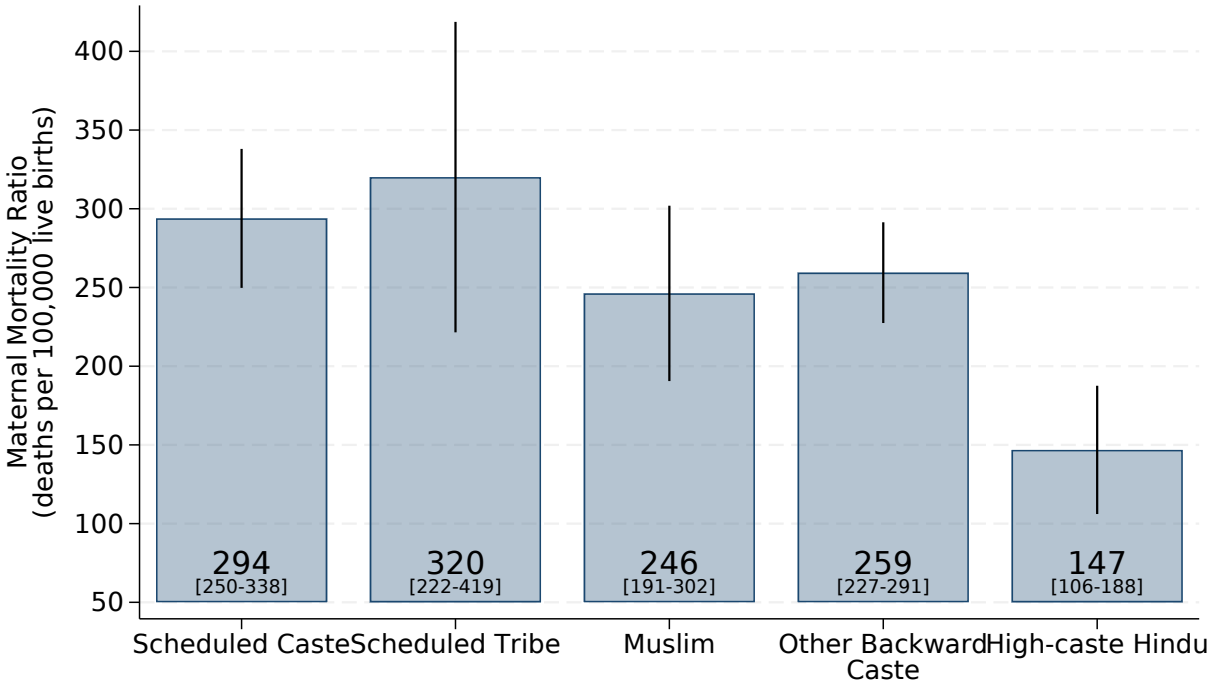
Vyas, Sangita, Payal Hathi, and Aashish Gupta. 2022. "Social disadvantage, economic inequality, and life expectancy in nine Indian states." *Proceedings of the National Academy of Sciences*, 119(10): e2109226119.

Figure 1: Age-specific maternal mortality and fertility rates



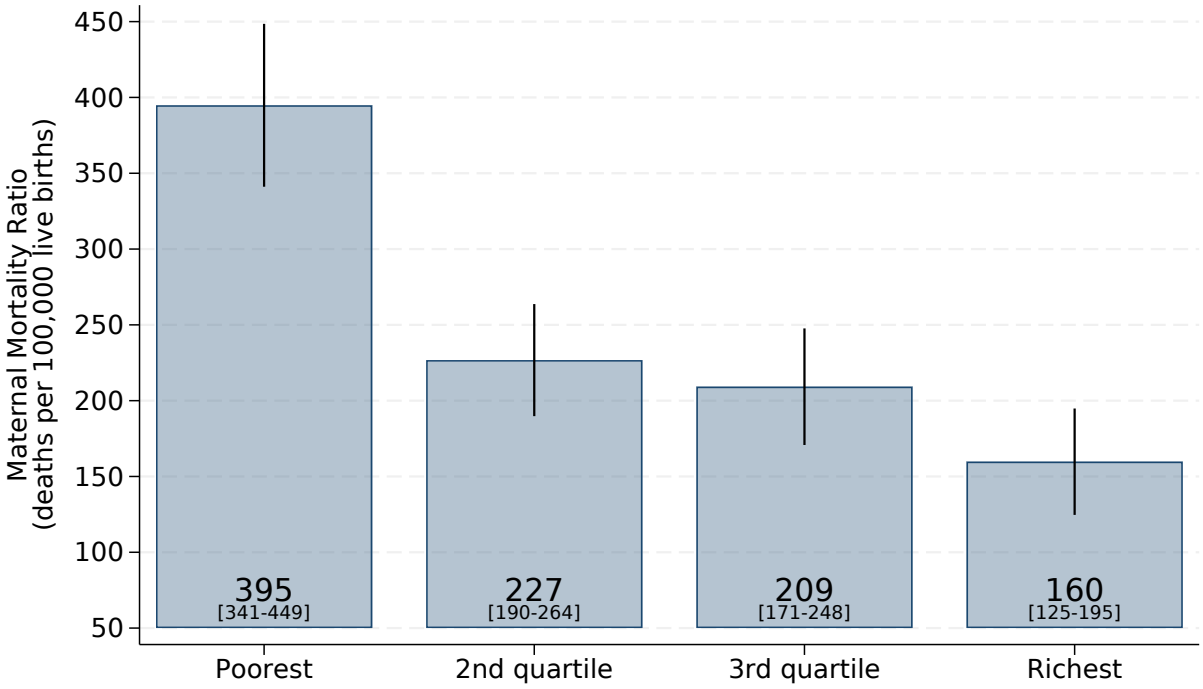
The bars show the maternal mortality rate for each age group, estimated based on the numerator of Equation 1. The vertical lines, and the numbers in brackets, are 95% confidence intervals estimated based on a cluster-bootstrap procedure. The red line shows age-specific fertility rates estimated based on the denominator of Equation 1. Fertility rates use the right axis. 95% confidence intervals estimated based on a cluster-bootstrap procedure are also plotted for fertility rates, but are not visible because they are small. Estimates use sample weights. Source: National Family Health Surveys 4 and 5.

Figure 2: MMR among marginalized groups substantially higher than among high-caste Hindus



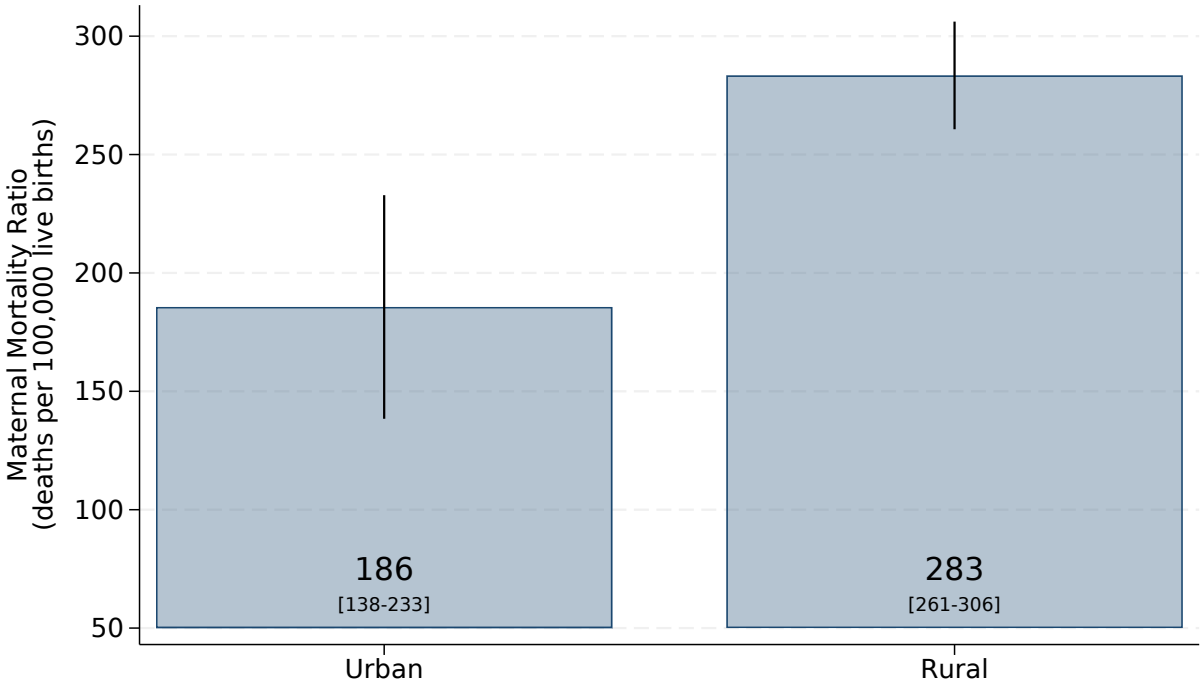
The vertical lines, and the numbers in brackets, are 95% confidence intervals estimated based on a cluster-bootstrap procedure. The maternal mortality ratio (MMR) for each group is estimated based on Equation 1. Estimates use sample weights. Source: National Family Health Surveys 4 and 5.

Figure 3: MMR among the poorest quartiles substantially higher than among richer quartiles



The vertical lines, and the numbers in brackets, are 95% confidence intervals estimated based on a cluster-bootstrap procedure. The maternal mortality ratio (MMR) for each quartile is estimated based on Equation 1. Estimates use sample weights. Source: National Family Health Surveys 4 and 5.

Figure 4: MMR among rural households substantially higher than among urban households



The vertical lines, and the numbers in brackets, are 95% confidence intervals estimated based on a cluster-bootstrap procedure. The maternal mortality ratio (MMR) for each quartile is estimated based on Equation 1. Estimates use sample weights. Source: National Family Health Surveys 4 and 5.

Table 1: Similar distribution of maternal deaths across age groups in NFHS and SRS

	Source: NFHS 4 and 5		Source: SRS 2014-2020
Age group	# of maternal deaths	% of maternal deaths	% of maternal deaths
(1)	(2)	(3)	(4)
15-19	72	7%	5%
20-24	358	37%	33%
25-29	234	24%	32%
30-34	145	15%	17%
35-39	71	7%	7%
40-44	37	4%	3%
45-49	41	4%	1%
Total	957	100%	100%

NFHS estimates use sample weights. SRS estimates are averaged from values in MMR Bulletins 2014-2016, 2015-2017, 2016-2018, 2017-2019, and 2018-2020. Sources: National Family Health Surveys 4 and 5, Sample Registration System.

Online Appendix

Figure A1: Similar all-cause female mortality rates between NFHS, SRS, and WPP

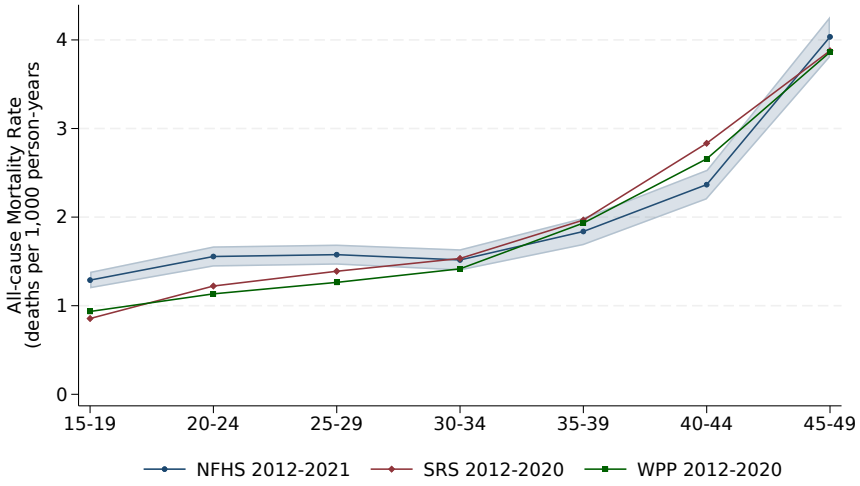


Figure A2: Similar fertility rates between NFHS, SRS, and WPP

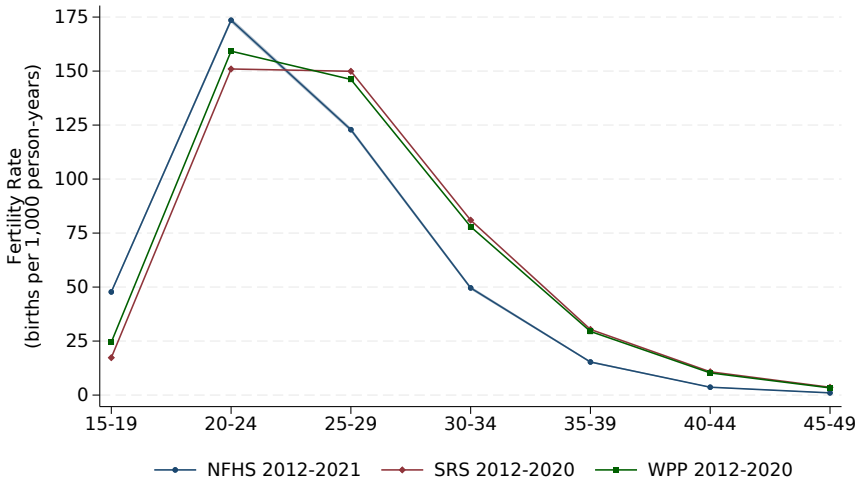
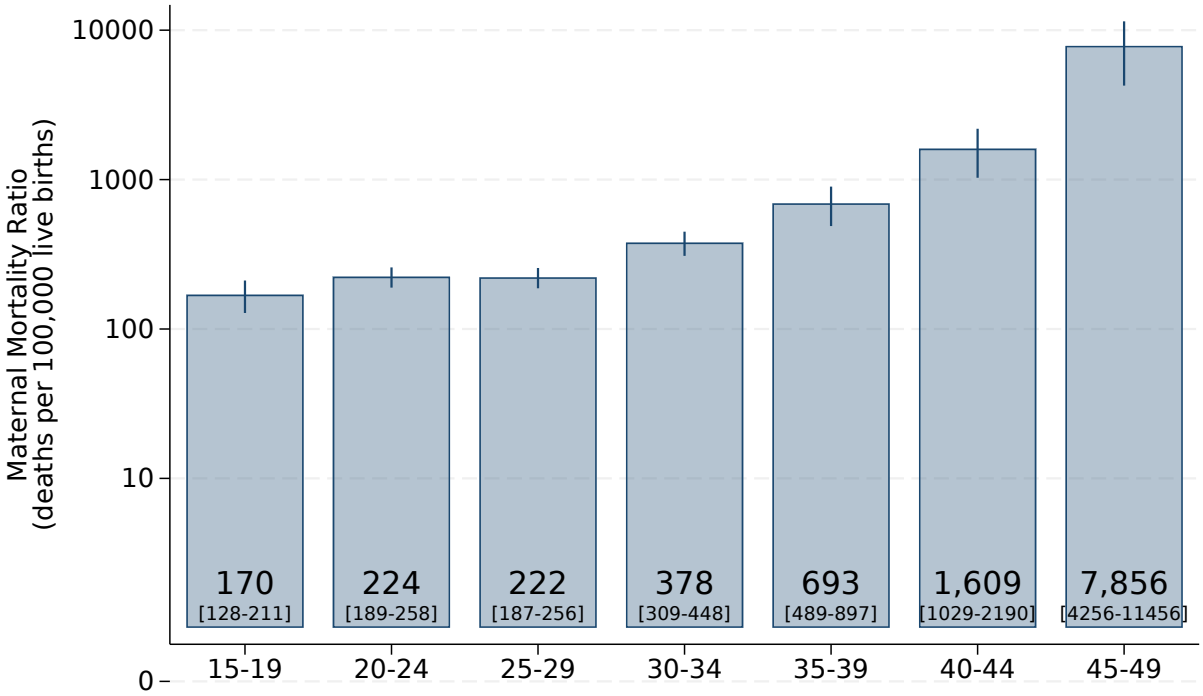


Figure A1 shows all-cause female mortality rates and Figure A2 shows fertility rates in the NFHS, Sample Registration System (SRS), and United Nations' World Population Prospects (WPP). We average yearly SRS and WPP estimates over the years 2012 to 2020. 2020 is the last available SRS report. 95% confidence intervals estimated based on a cluster-bootstrap procedure are shown for NFHS mortality and fertility rates. SRS and WPP do not provide 95% confidence intervals based on clustered errors. NFHS estimates use sample weights. Source: National Family Health Surveys 4 and 5, Sample Registration System Statistical Reports 2012-2020, United Nations' World Population Prospects.

Figure A3: MMR by age



The vertical lines, and the numbers in brackets, are 95% confidence intervals estimated based on a cluster-bootstrap procedure. The maternal mortality ratio (MMR) for each age group is estimated based on Equation 1. Estimates use sample weights. Source: National Family Health Surveys 4 and 5.