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Racial, Age, and Regional Disparities in Maternal Mortality in the USA, 1999–2020

Ibraheem M. Karaye[1] · Rida Nasir[1] · Odris Infante[1] · Humyra Ali[1] · Olivia Tiwari[1] · Amatul Marium[1] · Martine Hackett[1]

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Abstract

Background The health and well-being of mothers are essential for a thriving and prosperous society, yet maternal mortality remains a pressing public health problem in the USA. We aimed to examine the US trends in maternal mortality from 1999 to 2020 based on age, race/ethnicity, and census region.

Methods Data from the Centers for Disease Control and Prevention's Wide-ranging Online Data for Epidemiologic Research were used to identify maternal mortality cases. Temporal trends were analyzed using Joinpoint regression. Annual percentage changes, average annual percentage changes, and 95% confidence intervals were calculated.

Results The maternal mortality rate in the USA increased from 1999 to 2013, but has stabilized since then until 2020 (APC = −0.1; 95% CI: −7.4, 2.9). However, there have been recent increases among Hispanics at a rate of 2.8% per year (95% CI: 1.6, 4.0) from 1999 to 2020. The rates stabilized among non-Hispanic Whites (APC = −0.7; 95% CI: −8.1, 3.2) and non-Hispanic Blacks (APC = −0.7; 95% CI: −14.7, 3.0). Maternal mortality rates increased among women aged 15–24 years at a rate of 3.3% per year (95% CI: 2.4, 4.2) since 1999, among women aged 25–44 years at a rate of 22.5% per year (95% CI: 5.4, 34.7), and among women aged 35–44 years at a rate of 4% per year (95% CI: 2.7, 5.3). Regional disparities existed, with rising rates in the West at a rate of 13.0% per year (95% CI: 4.3, 38.4), and stable rates in the Northeast (APC = 0.7; 95% CI: −3.4, 2.8), Midwest (APC = −1.8; 95% CI: −23.4, 4.2), and South (APC = −1.7; 95% CI: −7.5, 1.7).

Conclusions While maternal mortality rates in the USA have stabilized since 2013, our analysis reveals significant disparities by race, age, and region. Therefore, it is essential to prioritize efforts to improve maternal health outcomes across all population subgroups to achieve equitable maternal health outcomes for all women.

Keywords Maternal mortality · Trends · Disparities · Inequities · USA

✉ Ibraheem M. Karaye
Ibraheem.m.karaye@hofstra.edu

Rida Nasir
Rnasir1@pride.hofstra.edu

Odris Infante
Oinfante1@pride.hofstra.edu

Humyra Ali
Hali4@pride.hofstra.edu

Olivia Tiwari
Otiwari1@pride.hofstra.edu

Amatul Marium
amarium1@pride.hofstra.edu

Martine Hackett
martine.hackett@hofstra.edu

[1] Department of Population Health, Hofstra University, 106 Hofstra Dome, Hempstead, NY 11549, USA

Introduction

Despite high healthcare expenditure, maternal mortality rates have worsened in the USA over the past two decades [1, 2]. Unlike the global trend, which has seen a 45% decline in mortality since 1990, the USA has seen a 58% increase in mortality rates [2, 3]. This puts the country in an alarming position, with a rate three times higher than France and 14 times higher than New Zealand [2].

Racial and ethnic disparities have been reported in US maternal mortality rates, with non-Hispanic Blacks being three times more likely to die from pregnancy-related causes than non-Hispanic Whites [1]. An analysis of the US Pregnancy Mortality Surveillance System from 2007 to 2016 revealed that non-Hispanic Blacks aged at least 30 years were four to five times as likely to die than non-Hispanic

Whites [4]. Mac Dorman et al. [5] assessed the racial/ethnic disparities in US maternal mortality using vital statistics data from 2016 to 2017. Their results showed that the rate for non-Hispanic Blacks was 3.55 times that for non-Hispanic Whites. The authors also found that non-Hispanic Black women were more likely to die from eclampsia, pre-eclampsia, and postpartum cardiomyopathy at a rate that was 5 times higher than non-Hispanic Whites [5].

Studies have consistently shown an association between increasing maternal age and a higher rate of maternal morbidity and mortality [6–8]. An analysis of hypertensive disorders in maternal mortality rates from 1979 to 2018 revealed that non-Hispanic Whites over the age of 25 years experienced increased maternal mortality due to hypertension-related disorders [6]. This finding is supported by the results of Hoyert [7], which documented that women under 25 years had a maternal mortality rate of 12.6 deaths per 100,000 live births, while women between 25 and 39 years had a rate of 19.9 deaths per 100,000 live births. Maternal mortality was the highest among women over 40 years, at 75.5 deaths per 100,000 live births. Another study reported a similar trend, with maternal mortality rates of 13.8 deaths per 100,000 live births for women under 25 years, 22.8 deaths per 100,000 live births for women between 25 and 39 years, and 107.9 deaths per 100,000 live births for women over 40 years [8].

The persistent increase in maternal mortality rates over the past two decades underscores the need for revisiting trend analysis to inform public health interventions. Previous studies have only partially, rather than comprehensively, assessed the trend in maternal mortality, and much of the literature was based on past data cycles [1, 5, 9]. This study aimed to comprehensively examine the trends in maternal mortality in the USA by age, race/ethnicity, and geographic region, from 1999 to 2020, using the latest national mortality data published by the Centers for Disease Control and Prevention (CDC).

Methods

Data Sources

Maternal mortality data were obtained from the CDC's Wide-ranging Online Data for Epidemiologic Research (WONDER) database [10], using the International Classification of Diseases Codes, 10th revision (ICD-10)-A34, O00-O95, and O98-O99. The identified maternal deaths documented in the USA from 1999 to 2020. Data on birth records from 1999 through 2020 were also obtained from the natality files in WONDER. Maternal mortality rates (MMR) (per 100,000 livebirths) were estimated by age group (15–24 years, 25–34 years, and 35–44 years), race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, Asian/Pacific Islander, American Indian/Alaska Native), and census region (Northeast, Midwest, South, and West). As WONDER is de-identified and publicly available, the Institutional Review Board review was not required for this study.

Statistical Analysis

Temporal trends in maternal mortality were analyzed using Joinpoint regression. The model initially assumes a linear trend in maternal mortality throughout the study period, with no Joinpoints. A statistical test is then conducted to evaluate the significance of adding a Joinpoint to the model. If the Joinpoint improves the model significantly, it is retained; otherwise, it is rejected. This process is repeated until the model with the optimal number of Joinpoints is derived using Monte Carlo permutation [11]. The annual percentage change (APC) is calculated to estimate the change in MMR between Joinpoint segments, and the average annual percentage change (AAPC) is estimated to quantify the rate of change in MMR over the entire study period (1999–2020). The 95% confidence intervals were obtained using the parametric and empirical quantile methods.

Model Characteristics and Parameter Settings

The outcome variable, log-transformed MMRper 100,000, was modeled over the independent variable, the year of death. The interval type was set to "annual" and an uncorrelated error option was selected to align with the constant variance of the standard errors. The default options were chosen for method (grid search), number of Joinpoints (0–4), model selection method (Monte Carlo permutation test), AAPC segment ranges (entire range, 1999–2020), and APC/AAPC/tau confidence intervals (parametric method).

All statistical analysis was conducted using Stata (version 17.0) and the Joinpoint Regression Program (version 4.9.1.0).

Results

Between 1999 and 2020, a total of 14,408 women died from maternal-related causes in the USA, corresponding to a MMR of 16.3 per 100,000 live births (95% CI: 16.2, 16.5). The highest mortality rates were observed among non-Hispanic Blacks (MMR = 71.5; 95% CI: 69.2, 73.7), individuals aged 35–44 years (MMR = 31.8; 95% CI: 30.9, 32.6), and those from the Southern census region (MMR = 20.4; 95% CI: 19.8, 21.0) (Table 1).

Table 1 Descriptive summary of maternal decedents in the USA, 1999–2020

Variable	Maternal mortality *n* (%)	Maternal mortality per 100,000 livebirths (95% CI)
Overall population	14,408 (100.0)	16.3 (16.2, 16.5)
[a]Race		
Non-Hispanic White	6305 (43.8)	23.8 (22.9, 24.7)
Non-Hispanic Black	4954 (34.4)	71.5 (69.2, 73.7)
Asian/Pacific Islander	590 (4.1)	22.1 (20.2, 24.0)
Hispanic	2298 (15.9)	11.5 (11.0, 11.9)
County		
Northeast	2307 (16.0)	16.1 (15.4, 16.8)
Midwest	2884 (20.0)	15.4 (14.9, 15.8)
South	6849 (47.5)	20.4 (19.8, 21.0)
West	2368 (16.4)	11.0 (10.5, 11.4)
Age (years)		
15–24	2668 (18.5)	9.6 (9.2, 9.9)
25–34	5978 (41.5)	12.8 (12.5, 13.1)
35–44	4210 (29.2)	31.8 (30.9, 32.6)

[a]American Indians/Alaska Natives were excluded due to low and unreliable death counts

Temporal Trends

The overall trend in maternal mortality saw a rise of 6.2% annually (95% CI: 5.1, 8.6) from 1999 to 2013, followed by a stationary rate through 2020 (APC = −0.1; 95% CI: −7.4, 2.9) (Table 2).

Trends by Race/Ethnicity

The MMR for non-Hispanic White women initially increased by 8.8% per year (95% CI: 7.3, 11.3) from 1999 to 2013 but stabilized thereafter through 2020 (APC = −0.7; 95% CI: −8.1, 3.2). Similarly, the trend for non-Hispanic Blacks increased by 5.1% per year (95% CI: 3.6, 16.8) from 1999 to 2013 and remained unchanged afterward through 2020 (APC = −0.7; 95% CI: −14.7, 3.0). For Hispanics, the MMR consistently increased at an annual rate of 2.8% from 1999 through 2020 (95% CI: 1.6, 4.0) (Table 2).

Trends by Age

The MMR increased in women aged 15–24 years by 3.3% per year from 1999 to 2020 (95% CI: 2.4, 4.2). Women aged 35–44 years also experienced an increasing trend, with MMR ascending by 4% per year (95% CI: 2.7, 5.3) from 1999 to 2020. In women aged 25 to 34 years, the MMR initially increased at an annual rate of 4.6% from 1999 to 2011 (95% CI: 3.4, 7.0), stabilized from 2011 to 2018 (APC = −1.2; 95% CI: −9.6, 1.5), and then increased dramatically by 22.5% annually from 2018 to 2020 (95% CI: 5.4, 34.7) (Table 2).

Trends by US Census Region

In the Northeastern region, the AAMR rose at an annual rate of 13.3% (95% CI: 7.1, 27.6) from 1999 to 2006, followed by stabilization through 2020 (APC = 0.7; 95% CI: −3.4, 2.8). The Midwestern region showed a similar pattern, with a 9.2% increase (95% CI: 5.7, 13.2) from 1999 to 2012, followed by stabilization from 2012 to 2020 (APC = −1.8; 95% CI: −23.4, 4.2). In the Southern region, the MMR was initially stable from 1999 to 2008 (APC = 4.1; 95% CI: −5.0, 6.7), increased at an annual rate of 12.9% from 2008 to 2013 (95% CI: 6.7, 23.3), and then stabilized again from 2013 through 2020 (APC = −1.7; 95% CI: −7.5, 1.7). In the Western region, the trend increased by 9.2% per year (95% CI: 2.1, 34.9) from 1999 to 2004, declined by 2.6% per year (95% CI: −15.5, −0.4) from 2004 to 2015, and increased by 13% per year from 2015 to 2020 (95% CI: 4.3, 38.4) (Table 2).

Discussion

The present study provides valuable insights into trends in MMR in the USA from 1999 to 2020. Our findings indicate that MMR has stabilized since 2013, but with significant disparities by race, age, and census region. These results highlight the importance of understanding the differences in maternal mortality trends across various population subgroups to inform targeted interventions and policies aimed at reducing maternal deaths.

Table 2 Annual percentage changes (APC) and average annual percentage changes (AAPC) in maternal mortality rates, USA, 1999–2020

Variable	Trend segment	Segment endpoints		APC (95% CI)	AAPC
		Lower	Upper		
Overall	1	1999	2013	*6.2 (5.1, 8.6)	*4.1 (3.1, 5.0)
	2	2013	2020	−0.1 (−7.4, 2.9)	
[a]Race/ethnicity					
Non-Hispanic White	1	1999	2013	*8.8 (7.3, 11.3)	*5.5 (4.2, 6.7)
	2	2013	2020	−0.7 (−8.1, 3.2)	
Non-Hispanic Black	1	1999	2013	*5.1 (3.6, 16.8)	*3.1 (1.6, 4.7)
	2	2013	2020	−0.7 (−14.7, 3.0)	
Hispanic	1	1999	2020	*2.8 (1.6, 4.0)	*2.8 (1.6, 4.0)
Age (years)					
15–24	1	1999	2020	*3.3 (2.4, 4.2)	*3.3 (2.4, 4.2)
25–34	1	1999	2011	*4.6 (3.4, 7.0)	*4.2 (3.1, 5.0)
	2	2011	2018	−1.2 (−9.6, 1.5)	
	3	2018	2020	*22.5 (5.4, 34.7)	
35–44	1	1999	2020	*4.0 (2.7, 5.3)	*4.0 (2.7, 5.3)
US Census Region					
Northeast	1	1999	2006	*13.3 (7.1, 35.0)	*4.7 (2.9, 7.1)
	2	2006	2020	0.7 (−3.4, 2.8)	
Midwest	1	1999	2012	*9.2 (6.1, 35.2)	*4.9 (1.6, 8.5)
	2	2012	2020	−1.8 (−23.4, 4.2)	
South	1	1999	2008	4.1 (−5.0, 6.7)	*4.1 (3.0, 5.0)
	2	2008	2013	*12.9 (6.7, 23.3)	
	3	2013	2020	−1.7 (−7.5, 1.7)	
West	1	1999	2004	*9.2 (2.1, 34.9)	*3.7 (2.2, 5.7)
	2	2004	2015	* −2.6 (-15.5, −0.4)	
	3	2015	2020	*13.0 (4.3, 38.4)	

[*] significant at $p < 0.05$; confidence interval does not include 0

[a] American Indians/Alaska Natives and Asians/Pacific Islanders were excluded due to low and unreliable death counts

While recent reports suggest increasing MMR, our study found that the overall MMR stabilized from 2013 to 2020. It is important to note that our study considered a longer 22-year time frame and utilized Joinpoint regression to identify statistically significant inflection points, which provides a more comprehensive and nuanced analysis of temporal trends in MMR. In contrast, the study by Thoma and Declercq [12] (2022) or Hoyert [8] (2022) only examined short-term changes in trend from 2019 to 2020. Our approach highlights the importance of considering long-term trends and employing appropriate analytical methods to better understand the dynamics of MMR.

We found varying trends in MMR across different racial and ethnic groups. Non-Hispanic Whites and non-Hispanic Blacks experienced stabilization in recent years, while Hispanics had a consistently increasing MMR over the entire 22-year study period. The increasing trend among Hispanics may be due to inadequate access to prenatal care and a higher prevalence of risk factors such as hypertension and diabetes [13–16]. Other factors such as language barriers, cultural beliefs, and immigration status may also limit their access to quality healthcare and timely prenatal care [13–16]. Future research should focus on exploring the underlying factors contributing to the persistent increase in MMR among Hispanics and identifying effective interventions to address this disparity.

Our analysis also revealed that recent trends in MMR increased across all age categories from 1999 to 2020. Specifically, the age groups of 15–24 years, 25–34 years, and 35–44 years experienced an increasing trend in MMR. This finding is concerning as it indicates that maternal mortality is not improving in any age group and highlights the need for continued efforts to improve maternal health outcomes across the lifespan. The increasing trend in MMR across all age groups may be due to several factors, including delays in seeking care, lack of access to quality healthcare, and inadequate prenatal care [17–19]. Future studies should explore these factors and develop targeted interventions to improve maternal health outcomes across all age groups. It is essential to address the disparities in

maternal health outcomes and work toward achieving equitable and optimal maternal health outcomes for all women.

The increasing mortality trend in the Western region since 2015, in contrast to stabilizing rates in other regions, highlights the need to investigate regional disparities in MMR in the USA. Several studies have reported regional differences in physical and mental health outcomes in the USA [20–23]. These differences may be attributed to a range of factors, including variations in access to healthcare, social determinants of health, and differences in demographic characteristics [20–23]. Further research is needed to understand the underlying drivers of these regional disparities and to develop targeted interventions to reduce maternal mortality rates in the Western region.

This study has several limitations. Although a pregnancy checkbox was introduced in 2003 on death certificates to improve maternal mortality identification, [24] its implementation varied across states and could result in overestimation of mortality trends. [5] However, a study that adjusted for these errors using national data from 2000 to 2014 found that the checkbox did not significantly alter the nation's worsening maternal mortality trends. [5] Since the pregnancy checkbox is not currently available through CDC WONDER, our study did not utilize it, which may limit our findings and potentially lead to biased estimates of APCs and AAPCs. Second, maternal mortality is a terminal outcome with limited opportunities for intervention. For every maternal death, there are 75 to 100 women who suffer a life-altering complication [25]. Therefore, future studies should consider replicating this study on pregnancy-related complications other than mortality. Third, the race/ethnicity designation of decedents was derived from informants, and when absent, determined by visual inspection, which may result in misclassification [26]. Thus, obtaining this information from reliable sources is vital in accurately understanding racial and ethnic disparities in maternal mortality. Finally, the proportion of births to US-born women has been increasing over time, and they may have higher rates of negative health behaviors and morbidity, such as obesity and diabetes mellitus, compared to foreign-born women [27]. This may partly explain the observed increase in MMR among US-born women. However, the lack of data on the mother's nativity limits our ability to fully understand the drivers of maternal mortality trends in the USA.

Despite the limitations, this study is an important contribution to the literature, as it utilizes a comprehensive national data source, enabling a thorough analysis of contemporary maternal mortality trends across several demographic subgroups and geographic regions. The results offer crucial insights into the necessity for culturally sensitive approaches and the urgency of addressing regional disparities in MMRs.

Conclusions

Significant disparities in MMR exist in the USA based on race, age, and census region. Among different racial groups, Hispanics have experienced a consistent increase in MMR, while non-Hispanic Whites and non-Hispanic Blacks initially experienced increases followed by stabilization. The increasing trend in the Western region highlights the need for further investigation into regional disparities in MMRs and the development of targeted interventions to address these disparities. Additionally, MMRs have increased across all age groups, indicating the need for continued efforts to improve maternal health outcomes across the lifespan. It is essential to understand the differences in maternal mortality trends among various population subgroups to inform targeted interventions and policies aimed at reducing maternal deaths and achieving equitable maternal health outcomes for all women.

Author Contribution The study conception and design were performed by IK. Material preparation, data collection, and analysis were performed by IK, RN, OI, HA, OT, and AM. The first draft of the manuscript was written by IK, RN, OI, HA, OT, and AM, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data availability The dataset used in this study is openly accessible through the CDC WONDER website, https://wonder.cdc.gov/ucd-icd10-expanded.html.

Code Availability Not applicable.

Declarations

Ethics Approval CDC WONDER is de-identified and publicly accessible. Therefore, this study was exempted from Institutional Review Board review.

Consent to Participate Not applicable.

Consent for Publication Not applicable.

Conflict of Interest The authors declare no competing interests.

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