

## Disparity in Maternal Mortality in New York City

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### Objective

To describe maternal deaths and 10-year trends in maternal mortality in New York City.

### Methods

All maternal deaths reported by surveillance of vital records (bearing ICD-9 codes 630-676) in New York City between 1989 and 1998 were studied. We reviewed death certificates and medical and autopsy records to collect age, race/ethnicity, country of birth, marital status, education level, residence at time of death, cause of death, and outcome of pregnancy. Trends analysis for maternal mortality rates was conducted, stratified by race. We conducted univariate and multivariate analysis to identify risk factors for maternal death.

### Results

Two hundred forty-three maternal deaths were reported, for an average maternal mortality rate (MMR) of 18.4 deaths per 100 000 live births during this period. Although the overall MMR decreased from 17.4 in 1989 to 13.7 in 1998, the MMR varied widely during the period with a nonsignificant trend ( $\chi^2$  for trend 2.09,  $p=.15$ ). However, the individual MMR for whites and blacks decreased significantly from 1989 to 1998. The black-white MMR ratio remained high throughout this period and varied from 2.2 in 1994 to 14.8 in 1998. Women who were 35 years of age or older or non-Hispanic black had an increased risk of a pregnancy-related death. The leading causes of death were hemorrhage, embolism, and infection.

### Conclusion

Racial disparity in maternal mortality is a cause for concern in New York City. Further studies of maternal mortality are needed to develop interventions to reduce the MMR and the black-white gap. (*JAMWA*. 2005;60:52-57)

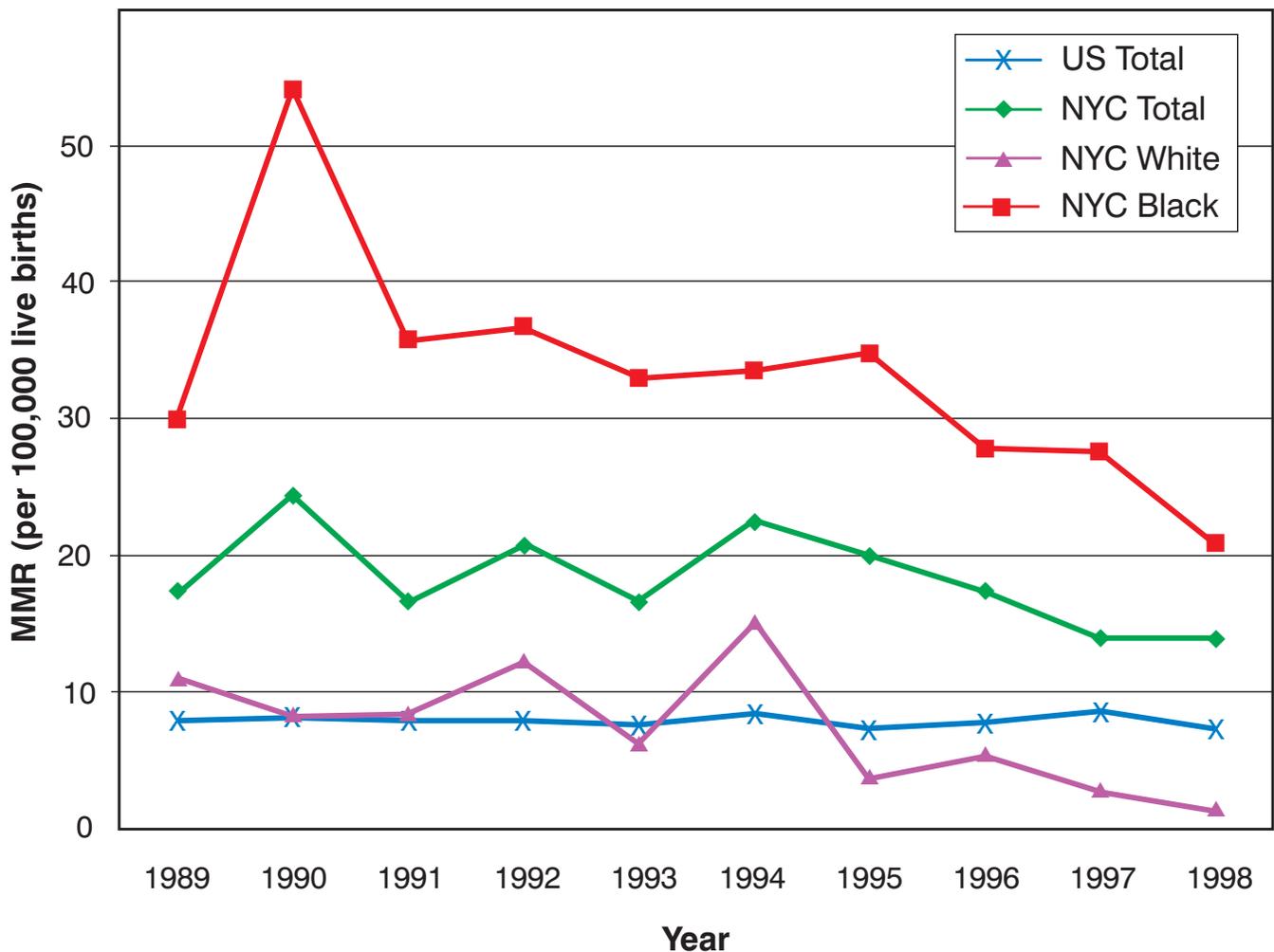
The maternal mortality rate (MMR) is a sensitive indicator of the health status of a population, and major changes in MMR are considered important events requiring investigation. Despite many advances in medical technology during the last 50 years, the MMR has not declined significantly since the early 1980s. Although individual maternal deaths in the United States are uncommon events (281 in 1998),<sup>1</sup> the annual US MMR remained at approximately 8.0 deaths per 100 000 live births from 1982 to 1997.<sup>2,3</sup> This falls far short of the Healthy People 2000 and 2010 objectives of 3.3 maternal deaths per 100 000 live births.<sup>4,5</sup> In addition, the disparity in the MMR between blacks and whites remains substantial; from 1992 to 1997, blacks had a maternal mortality rate more than 3 times higher than that of whites.<sup>2,3</sup>

In New York City, vital records data indicate that both the MMR and the black and white gap are higher than the US average.<sup>6</sup> Risk factors for maternal deaths include older age, black or Hispanic race/ethnicity, being unmarried, and fewer years of education.<sup>7-13</sup> To better understand the epidemiology and risk of maternal death in New York City and, ultimately, to design and implement effective interventions to reduce maternal mortality, we conducted an analysis of maternal deaths spanning 10 years. The objectives of this study were to: 1) present the trend in maternal mortality in New York City and 2) analyze the risk factors and causes of maternal mortality and its relation to birth outcomes.

### Methods

According to the World Health Organization at the time, a maternal death was defined as "death of a woman whose cause of death is

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**Figure.** Maternal mortality rate by race, New York City, 1989-1998. The figure shows the MMR in the United States (overall only) and in New York City from 1989 to 1998 overall and stratified by race. Blacks had a much higher MMR than whites did.

assigned to complications of Pregnancy, Childbirth, and Puerperium” (ICD-9 codes 630-676).<sup>14</sup> These codes indicate deaths caused by pregnancy and occurring during pregnancy or within 42 days of pregnancy outcome. The MMR was calculated as the number of maternal deaths per 100 000 live births in a given year.

The New York City Department of Health and Mental Hygiene (NYCDOHMH) Office of Vital Statistics tabulates maternal death certificates bearing ICD-9 codes 630 to 676, conditions related to pregnancy and childbirth.<sup>14</sup> ICD-9 codes are assigned independently at the city level by trained nosologists. In addition, death certificates have a box indicating if the patient had a pregnancy within the last 12 months. A copy of all death certificates with those ICD-9 codes and those with the pregnancy box checked off are sent to the Of-

fice of Family Health for review. Autopsy reports and medical records are requested and reviewed by a physician. This report is restricted to those death certificates that had ICD-9 codes 630 to 676 only, regardless of whether the pregnancy box was checked off. Additionally, maternal deaths were excluded if they occurred beyond 42 days of pregnancy outcome or if the ICD-9 code was missing.

All data on live births were obtained from the NYCDOHMH Office of Vital Statistics. For this report, we selected maternal deaths that occurred between 1989 and 1998. Death certificates, autopsy reports, and medical records, when available, were reviewed to collect information on age, race/ethnicity, country of birth, marital status, education level, borough of residence at time of death, date and cause of death, and outcome of pregnancy. For this report,

**Table 1.** Maternal Mortality Rate (MMR), by Demographic Characteristics, New York City, 1989-1998

	<b>Maternal Deaths, n (%) (n=243)</b>	<b>Live Births, n (n=1 324 173)</b>	<b>MMR, per 100 000 live births</b>	<b>Risk Ratio (95% confidence interval)</b>	<b>P Value</b>
<b>Maternal age</b>					
15-19	17 (7)	131034	13.0	Referent	
20-24	40 (16)	292931	13.7	1.05 (0.58, 1.93)	.86
25-29	50 (21)	369003	13.6	1.04 (0.59, 1.88)	.88
30-34	62 (26)	327346	18.9	1.46 (0.83, 2.59)	.16
35-39	52 (21)	162121	32.1	2.47 (1.39, 4.44)	<.001
40+	22 (9)	38371	57.3	4.42 (2.26, 8.70)	<.001
<b>Race/ethnicity</b>					
White non-Hispanic	24 (10)	387449	6.2	Referent	
Black non-Hispanic	139 (57)	386411	36.0	5.81 (3.70, 9.19)	<.001
Hispanic	59 (24)	424500	13.9	2.24 (1.37, 3.71)	<.001
Asian/other	13 (5)	117001	11.1	1.79 (0.87, 3.67)	.09
<b>Marital status</b>					
Married	94 (39)	709775	13.2	Referent	
Not married	137 (56)	614341	22.3	1.68 (1.28, 2.21)	<.001
<b>Education</b>					
≤ 12 years	167 (69)	810565	20.6	Referent	
> 12 years	61 (25)	467261	13.1	0.63 (0.47, 0.86)	.002
<b>Country of birth</b>					
United States	125 (51)	676297	18.5	Referent	
Other	106 (44)	640532	16.5	0.90 (0.69, 1.16)	.40
<b>Borough</b>					
Bronx	45 (19)	240619	18.7	Referent	
Brooklyn	86 (35)	428281	20.1	1.07 (0.74, 1.56)	.70
Manhattan	48 (20)	208039	23.1	1.23 (0.81, 1.89)	.31
Queens	40 (16)	289784	13.8	0.74 (0.47, 1.15)	.16
Staten Island	7 (3)	60650	11.5	0.62 (0.25, 1.42)	.23
Not NYC	10 (4)	95984	10.4	0.56 (0.26, 1.14)	.09

Note: Column of death and live birth totals do not match the total number of deaths and live births because of missing values.

cause of death information was based solely on the ICD-9 cause of death code. The MMR was defined as the number of maternal deaths divided by the number of live births in the same category per 100 000. (The MMR is technically a ratio but is also referred to as a rate.) The data were entered into a computerized database using EpiInfo software.<sup>15</sup>

Data were managed and analyzed using EpiInfo version 6.0<sup>15</sup> and Statistical Analysis Software (SAS Institute Inc., Cary, NC). The trend in NYC MMR was compared with that of the United States overall and for blacks and whites; data were not available by Hispanic ethnicity for the United States during the time period under study. The rest of the NYC analysis was done by race and ethnicity. The trend in maternal mortality was analyzed by dividing the data into 2

5-year periods: 1989 to 1993 and 1994 to 1998. The differences in overall MMR and in the MMRs for blacks and whites between the 2 time periods were examined. We also conducted univariate analysis to examine the demographic variables. The main causes of death were tabulated by pregnancy outcome. The multivariate logistic regression analysis included demographic variables that were statistically significant ( $p < .05$ ) in the univariate analysis.

## Results

Of 296 possible maternal deaths reported between 1989 and 1998, 243 had ICD-9 codes in the maternal range (630-676), for an average MMR of 18.4 per 100 000 live births during the 10-year period (see figure). The 53 excluded

**Table 2.** Causes of Maternal Death, by Outcome of Pregnancy, New York City, 1989-1998, Number (Percent)

Cause of Death	Outcome of Pregnancy						Total
	Live Birth	Stillbirth	Ectopic	Abortion	Undelivered	Unknown	
Hemorrhage	31 (25)	5 (39)	22 (79)	12 (35)	2 (12)	2 (7)	74 (30)
Embolism	37 (30)	2 (15)	0 (0)	5 (15)	10 (59)	4 (14)	58 (24)
Pregnancy-induced hypertension	24 (20)	3 (23)	0 (0)	2 (6)	0 (0)	4 (14)	33 (14)
Infection	15 (12)	2 (15)	3 (11)	5 (15)	3 (18)	5 (18)	33 (14)
Other	16 (13)	1 (8)	3 (11)	10 (29)	2 (12)	13 (46)	45 (19)
Total	123 (100)	13 (100)	28 (100)	34 (100)	17 (100)	28 (100)	243 (100)

deaths were initially classified as “maternal” because the box indicating pregnancy within the last 12 months was checked off, but they did not fall within the ICD-9 code range 630 to 676 or had missing ICD-9 codes at the time of this report. The MMR in New York City was consistently higher than that of the United States. There was no difference in the overall MMR in NYC from the period of 1989-1993 (19.1 per 100 000 live births) compared with 1994-1998 (17.5) or in the race-specific MMRs for these 2 time periods. Although the MMR decreased for both whites and blacks, the ratio of black to white MMR was consistently high for all years; the black-white MMR ratio increased from 4.0 to 4.8 from 1989-1993 to 1994-1998. Among whites (including whites of Hispanic origin), the overall MMR was 7.8 and among blacks (including blacks of Hispanic origin) it was 33.7, more than 4 times that among whites.

Demographic characteristics of the 243 women who died and stratified MMRs are shown in Table 1. Age had a significant impact on the risk of maternal death: women who were 35 years of age or older had a higher MMR than younger women. Black non-Hispanic women had nearly 6-fold higher probability of dying as a consequence of pregnancy compared with white non-Hispanic women. Hispanic women were twice as likely to die as a result of pregnancy compared with white non-Hispanic women. Unmarried women were more likely to experience a maternal death than married women were. Women with 12 years or less of education had a higher risk of maternal death than did women who had more than 12 years of education. There was no significant difference in risk of maternal death by borough of residence or country of birth.

The outcome of pregnancy was known for 215 (88%) of the 243 maternal deaths (Table 2); the majority were associated with live birth (57%), abortion (16%), or ectopic pregnancy (13%). The overall leading cause of maternal death was hemorrhage, followed by embolism; however, the lead-

ing causes of death varied depending on the outcome of the pregnancy. For women whose pregnancies ended in live birth, the leading causes of death were embolism (pulmonary or amniotic fluid embolism), hemorrhage, and complications of pregnancy-induced hypertension. Almost 80% of deaths associated with an ectopic pregnancy were from hemorrhage, whereas the primary causes for deaths associated with abortion were hemorrhage, followed by infection and embolism. Nearly 60% of the women who died without delivering died from an embolism.

The logistic regression showed an independent increased risk of death for age ( $\geq 35$  years) and race (non-Hispanic black) when controlling for all variables (Table 3). Women who were 35 years old or older had 3 times the risk of dying compared with younger women (odds ratio [OR] 3.08; 95% confidence interval [CI] 2.28, 4.15). Black non-Hispanic women had nearly 4 times the risk of dying as a consequence of pregnancy compared with white non-Hispanic women (OR 3.76; CI 2.47, 5.72). No significant difference was found in other ethnic groups, educational level, or marital status.

## Discussion

Our study showed that from 1989 to 1998, the MMR in New York City declined 21 percent, from 17.4 deaths per 100 000 live births to 13.7 deaths per 100 000 live births, but varied greatly during the period under study. However, the MMR in 1998 was still 4 times higher than the Healthy People 2000 Objective.<sup>5</sup> In addition, the NYC MMR for each year during this period was also consistently higher than that of the United States.<sup>2,3,16,17</sup>

Our analysis revealed a large disparity in the MMR between blacks and whites, with wide variations in the black-white MMR ratio for each year during this period. The higher risk of maternal death among black women has been noted previously, and this racial gap has existed since data on race in maternal mortality surveillance became available in

**Table 3.** Risk Factors for Maternal Mortality in New York City, 1989-1998, Logistic Regression Analysis

Characteristic	Adjusted Odds Ratio (95% Confidence Interval)	P Value
Maternal age		
<35 years	Referent	
≥35 years	3.08 (2.28, 4.15)	<.001
Education		
≤12 years	Referent	
>12 years	0.75 (0.54, 1.02)	.07
Marital status		
Married	Referent	
Unmarried	1.14 (0.84, 1.55)	.40
Race/ethnicity		
White non-Hispanic	Referent	
Black non-Hispanic	3.76 (2.47, 5.72)	<.001
Hispanic	1.56 (0.98, 2.48)	.06
Asian	0.45 (0.16, 1.26)	.13

Note: Logistic regression model included all variables significant in the univariate analysis.

1979.<sup>7-11,18,19</sup> A study of reported maternal deaths from 1981 to 1983 in New York City showed that black non-Hispanic women had a risk of maternal death 4 times higher than that of white non-Hispanic women.<sup>8</sup> Additionally, although some states have reached the national Healthy People 2000 goal<sup>5</sup> in white women, no state has come close to achieving this goal for black women.<sup>9</sup> Potential reasons for this higher MMR among black women include higher prevalence of diabetes, hypertension, and other medical problems; less access to care; lower-quality care; and lower socioeconomic status.<sup>20</sup> These potential factors should be evaluated through in-depth maternal mortality review.

This study also found that risk factors for maternal mortality that existed 20 years ago, such as race and age, have remained the same.<sup>7-13</sup> A statistically significant increasing risk of death among older women (age 30 years or over) was documented previously in New York City<sup>8</sup> and continues to exist.

Our study had certain limitations. We studied only those maternal deaths that had been reported by routine surveillance, a passive system that has been shown to undercount maternal mortality both in the United States and worldwide.<sup>21-24</sup> Studies using active surveillance methods for maternal mortality have shown increases in case ascertainment up to 153% beyond that reported by routine surveillance.<sup>22,25-31</sup> Active surveillance methods have included searching hospital discharge or autopsy databases or linking

vital records databases. An epidemiological study of maternal deaths relying solely on data gathered through routine surveillance may miss deaths that could influence the outcome of the results. However, we limited our report to maternal deaths reported by routine surveillance, because it is more uniformly done across reporting areas and can serve as a basis for comparison. Additionally, our analyses could not adjust for differences in socioeconomic status of the women, which could be a possible explanatory factor for risk of maternal death.

Given the relatively low numbers of maternal deaths reported in the United States, the importance of studying maternal mortality has been questioned. We believe that this is an important issue that requires continued scrutiny for several reasons. First, reported numbers rely on routine surveillance methods that continue to underestimate maternal mortality, therefore, underreporting is likely to be significant. Second, maternal mortality represents only the most obvious aspect of the larger problem of maternal morbidity. In 1998, in New York City, there were 82 922 hospital admissions related to pregnancy complications, not including those associated with a normal delivery.<sup>31</sup> In comparison, there were fewer admissions for neoplasms (55 032) and only slightly more for heart disease (94 727).<sup>32</sup> A study conducted in New Mexico found that the antepartum hospitalization rate was 20.1 per 100 deliveries for 1995-1996.<sup>33</sup> Third, each maternal death is a great tragedy and unfortunately, despite the reported low numbers, there have been no significant improvements in maternal mortality during the last 20 to 30 years.<sup>9,18</sup> Despite major advances in medical technology, the leading causes of maternal death continue to be the same as those reported since the beginning of the 20<sup>th</sup> century: hemorrhage, embolism, complications from pregnancy-induced hypertension, and infection, with just a shift in the order of the leading causes.<sup>18</sup> And lastly, the persistent and large racial gap in maternal death between blacks and whites is a major reproductive health issue that needs to be addressed.

Our study indicates that many maternal deaths in NYC are preventable (the leading causes of death are ones that have been shown to be preventable, such as hemorrhage or infection, especially given the fewer deaths among white women, indicating that deaths have been prevented in certain racial groups) and that efforts should be made to reduce the black MMR to the level of the white MMR. Studying maternal mortality can assist in finding preventable risk factors and directing resources to improve the understanding of the more common pregnancy-related morbidities and to develop prevention strategies.

In conclusion, we recommend that maternal deaths be regularly reviewed and discussed by a multidisciplinary maternal mortality review committee. The epidemiology of maternal mortality should be reviewed annually to identify areas for intervention and to reduce the MMR and the existing racial gap. We also recommend enhanced active surveillance methods for maternal mortality and that future studies of maternal deaths be conducted using data from active surveillance, based on numerous studies that showed that rou-

tine surveillance underestimates maternal mortality.<sup>22-31</sup> Additionally, research efforts should explore the issue of maternal morbidity in order to reduce the scope of adverse health effects associated with pregnancy.

## Acknowledgements

We thank the New York City Department of Health and Mental Hygiene, Office of Vital Statistics for providing the data. The study was supported by the NYC Department of Health and Mental Hygiene.

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