Pregnancy-Associated Mortality

New York City, 2001–2005

NYC Health

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Executive Summary

The dramatic decline in maternal mortality in the United States is one of the great public health success stories of the 20th century. During this time period, the maternal mortality rate dropped nearly 100%. Among the factors that contributed to this decline were the standardization of institutional practice guidelines in hospitals, increased use of aseptic technique and antibiotics in hospitals, a shift from home to hospital deliveries, use of blood transfusions, the legalization of abortion , and the formation of maternal mortality review committees.[1]

Despite this remarkable achievement, the maternal mortality ratio (MMR) – the number of maternal deaths per 100,000 live births – has not declined in the US for more than 20 years. The 2006 US MMR was three times higher than the Healthy People 2010 goal (13.3 versus 4.3 maternal deaths per 100,000 live births),[2, 3, 4] and the US MMR ranked 34th among World Health Organization (WHO) member nations in 2005.[5] An even more sobering picture emerges in New York City, where, in the last 40 years, the MMR has consistently been above the national average and is currently among the highest in the nation.[2, 6] National and local data also reveal striking racial disparities: in the US, black women are three to four times more likely to suffer a pregnancy-related death than white women.[2] In NYC, the disparity is even larger, with black women more than seven times more likely to die from pregnancy-related causes than white women.[6]

This report focuses on the 161 maternal deaths that occurred in NYC between 2001 and 2005 that were pregnancy-related (either caused or exacerbated by pregnancy). It summarizes the causes and conditions of death for these women and offers select information regarding their demographic, antepartum, and delivery characteristics. The report also provides an overview of the 104 maternal deaths that were not pregnancy-related.

Among the report's findings are:

- Black, non-Hispanic women were more than seven times more likely than white, non-Hispanic women to die from pregnancy-related causes.
- Women 40 years of age and older were 2.6 times more likely than women under age 40 to suffer a pregnancy-related death.

- Almost half of all women who died from pregnancy-related causes (49%) were classified as obese.
- More than half of women who died from a pregnancy-related cause (56%) had at least one chronic health condition (e.g., hypertension, asthma and heart-related conditions).
- The pregnancy outcome for most women who died from a pregnancy-related cause (66%) was a single live birth.
- Embolism, hemorrhage, infection, and pregnancy-induced hypertension accounted for nearly two thirds (63%) of all pregnancy-related deaths.
- Injury accounted for half (50%) of the maternal deaths that were not pregnancy-related. Homicide accounted for 44% of these injury deaths. More than half of the homicide deaths (52%) were linked to intimate-partner violence.

The data in this report illuminate the problem of pregnancy-associated mortality in NYC and, in particular, its outsize impact on black women. Although the causal relationships are not well established, maternal mortality shows an association with obesity, underlying chronic illness, and poverty – all conditions that disproportionately affect NYC's black population.

There is no simple solution to maternal mortality, a problem that has remained intractable for decades; rather, what is needed is an integrated, multi-component approach that involves women, communities, providers, maternity facilities, and policy makers. The NYC Department of Health and Mental Hygiene (NYC DOHMH) is committed to identifying and examining every maternal death in NYC. Through these efforts, the department strives to stimulate dialogue and foster partnerships with stakeholders, inform clinical practice and policy development, and, ultimately, promote maternal health and reduce maternal mortality.

Methods

This report presents the results of enhanced surveillance of NYC maternal deaths between 2001 and 2005. Enhanced surveillance involves using multiple sources to identify deaths of women while pregnant or within one year of the end of pregnancy; this method has been shown to improve case ascertainment and to offer better insight into the medical and social factors that contribute to maternal deaths.[7, 8]

Standard surveillance, in contrast, focuses on a limited subset of maternal deaths (those that occur while a woman is pregnant or within 42 days of the end of pregnancy that are related to or aggravated by the pregnancy or its management). Standard surveillance relies solely upon the death certificate to identify maternal deaths, whereas enhanced surveillance uses multiple sources (described below). The Centers for Disease Control and Prevention (CDC) uses standard surveillance for its calculations and reporting of US maternal mortality statistics, as do most other World Health Organization (WHO) member nations. NYC's enhanced surveillance is conducted by the Health Department's Bureau of Maternal, Infant, and Reproductive Health (BMIRH).

BMIRH relies on four sources for enhanced surveillance of maternal deaths: 1) NYC DOHMH Bureau of Vital Statistics; 2) NYC Office of Chief Medical Examiner; 3) New York State Department of Health Statewide Planning and Research Cooperative System; and 4) NYC DOHMH Injury Epidemiology Unit (for homicide cases only).

Sources for Maternal Death Identification

NYC DOHMH Bureau of Vital Statistics (BVS)

The BVS provides ongoing notification to BMIRH of all maternal deaths in NYC. Maternal deaths are identified based on an ICD-10 code indicating a pregnancy-related cause of death (codes O00–O99 for the time period covered by this analysis) and/or a checkbox on the death certificate indicating that the woman was pregnant within one year prior to death. BVS provides BMIRH with a list of all maternal deaths that meet these criteria as well as with copies of the death certificate and corresponding birth or spontaneous abortion certificates (when available). BMIRH uses the information on the death certificate to request medical and autopsy records for case review.

Office of Chief Medical Examiner (OCME)

Each year, BMIRH requests an OCME review of the NYC autopsy database using a specific set of keywords (gesta, preg, amnio, abortion, ectopic, placenta, partum) to identify possible maternal deaths. For each death identified, BMIRH requests the death certificate and corresponding birth or spontaneous abortion certificates from BVS. Medical, autopsy, and other supplementary report records are reviewed on-site at the OCME.

New York State Department of Health Statewide Planning and Research Cooperative System (SPARCS)

The New York State Department of Health uses SPARCS to track all hospital discharges. Deaths that occur in hospitals are included in the SPARCS dataset as discharges. Each year, BMIRH receives SPARCS data for all NYC hospitalizations of women aged 10–55 that have ended with death. The SPARCS dataset includes select patient demographic characteristics, diagnosis and procedure codes, hospital charges, and mode of payment for each hospitalization. BMIRH identifies possible maternal deaths by running the data through a SAS® program that screens for pregnancy-related keywords in either the diagnostic or procedure codes [see Pallin (2002) for detailed methodology]. For each new case identified through this method, BMIRH requests death certificates, corresponding birth or spontaneous abortion certificates, medical records, and autopsy reports.

NYC DOHMH Injury Epidemiology Unit (IEU)

The IEU monitors intentional and unintentional injuries in NYC through death certificate, SPARCS, and NYC emergency department discharge data. Homicide deaths among women aged 12 and older in which the woman was pregnant in the year before death are submitted by BMIRH to IEU for cross-matching with the IEU's female homicide database. This linkage allows for ascertainment of the relationship of the perpetrator to the decedent. Death certificates, corresponding birth or spontaneous abortion certificates, medical records, and autopsy reports for any additional cases identified through this method are then requested from the respective office.

Record Review

All records for a case, including death certificates, corresponding birth or spontaneous abortion certificates, medical records and autopsy reports, are reviewed by an obstetrician/gynecologist using a standard chart abstraction form adapted from guidelines in the CDC's National Pregnancy Mortality Surveillance Coding Manual. Demographic information collected includes maternal age, race/ethnicity, borough of residence, education, and place of birth. Medical information collected includes medical and obstetric history, current pregnancy outcome, location of death, and cause of death. After reviewing all available records, the CDC's National Pregnancy Mortality Surveillance Coding Manual is used to assign a cause of death that more clearly details the relationship of the index pregnancy to the death.

Key Findings: Maternal Mortality Trends

US Versus NYC Maternal Mortality Ratios

The maternal mortality ratios presented in Figures A-1a, A-1b and A-1c and in Tables A-1 and A-2 are based on standard surveillance. Standard surveillance uses only cause of death information as reported on death certificates to identify and classify maternal deaths. A maternal death is defined as those deaths that are either caused by or exacerbated by the pregnant state and which occur either during pregnancy or within 42 days of the end of a pregnancy.

- From 1900 to 2005, the maternal mortality ratio (MMR) declined 96.8% in NYC (from 538.0 to 17.1) and 98.2% in the US (from 850.0 to 15.1). (Figure A-1a, Table A-1)
- Between 1980 and 2005 the US MMR ranged from a low of 6.6 in 1987 to a high of 15.1 in 2005. During this same period of time, the MMR in NYC ranged from a low of 12.9 in 1998 to a high of 39.2 in 1983. (Figure A-1b, Table A-1)
- The average NYC MMR between 2001 and 2005 (23.1) was two times higher than the US MMR (11.8) and five times greater than the Healthy People 2010 goal of 4.3. (Figure A-1c, Table A-2)

BMIRH Enhanced Surveillance: Pregnancy-Associated Mortality

BMIRH enhanced surveillance uses multiple sources for the identification and review of cases of maternal deaths that occur either during pregnancy or within one year of the end of a pregnancy regardless of the cause of death. This is referred to as pregnancy-associated mortality. The multiple sources of data are medical charts, autopsy reports, and death and birth certificate information. All remaining figures and tables in this report are based on BMIRH enhanced surveillance.

- 266 pregnancy-associated deaths were identified between 2001 and 2005. (Figure A-2)
- The majority (60%) of pregnancy-associated deaths were pregnancy-related. (Figure A-2)
- From 2001–2005, the pregnancy-associated mortality ratio (PAMR) ranged from 37.4 to 50.8 and averaged 43.0. (Figure A-3, Table A-3) The decrease from 50.8 to 44.8 was not statistically significant.
- From 2001–2005, the pregnancy-related mortality ratio (PRMR) ranged from 20.9 to 33.9 and averaged 26.0. The decrease from 33.9 to 25.3 was not statistically significant. (Figure A-3, Table A-3)

Figure A-1a:
US and NYC Maternal Mortality Ratios (MMR), 1900–2005*

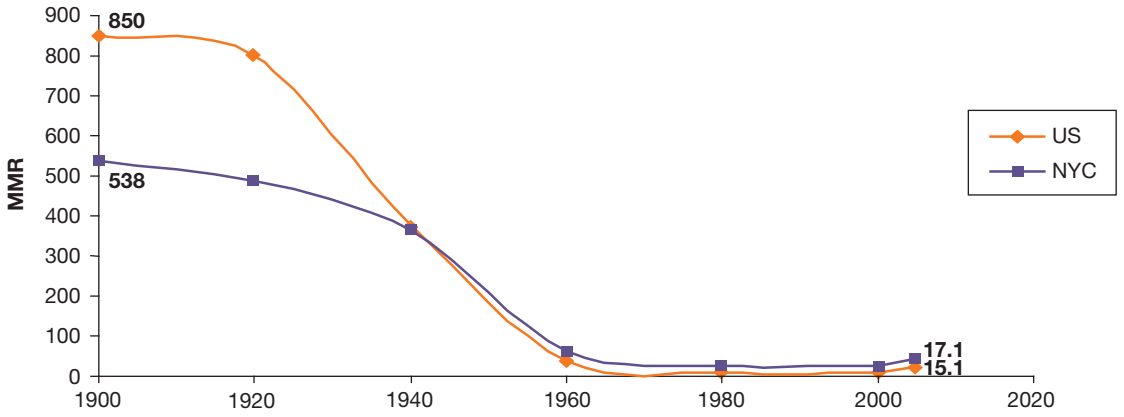


Figure A-1b:
US and NYC Maternal Mortality Ratios (MMR), 1960–2005*

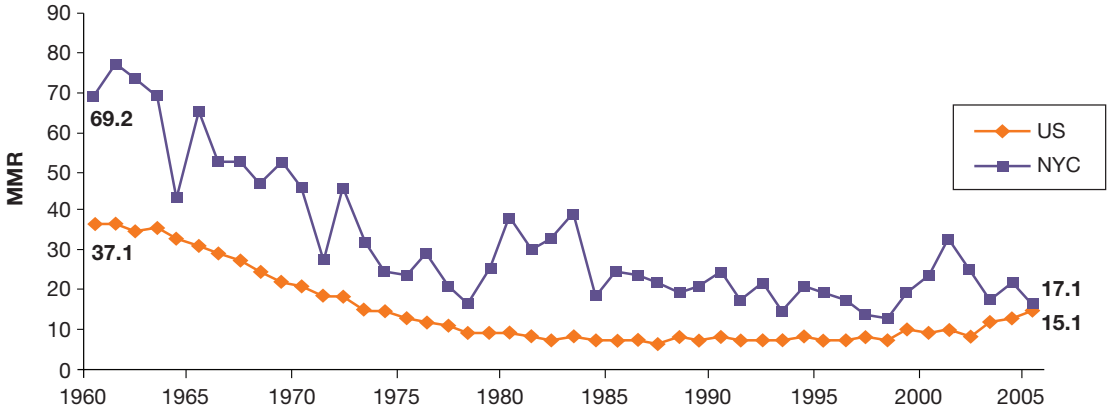
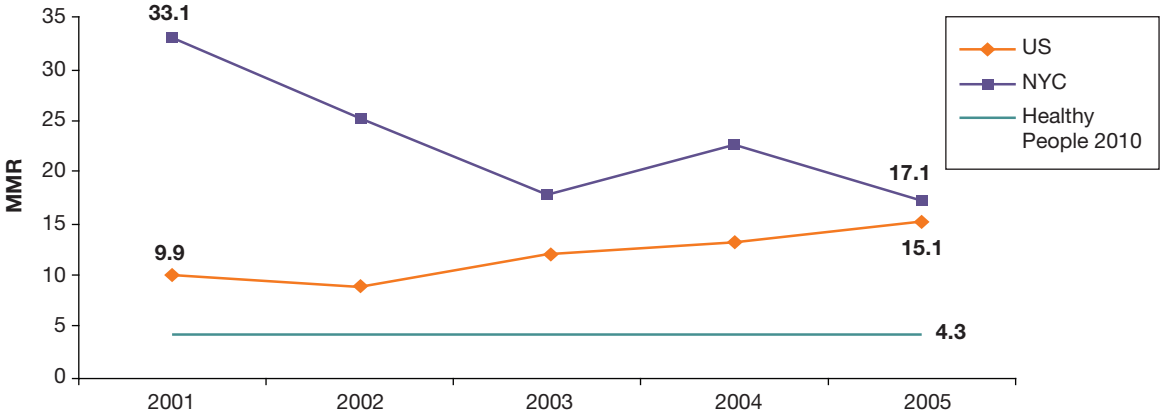


Figure A-1c:
US and NYC Maternal Mortality Ratios (MMR), 2001–2005*



*These data were taken from published US and NYC maternal mortality data derived from standard surveillance methods.

Table A-1:
US and NYC Maternal Mortality Ratios, 1900–2005*

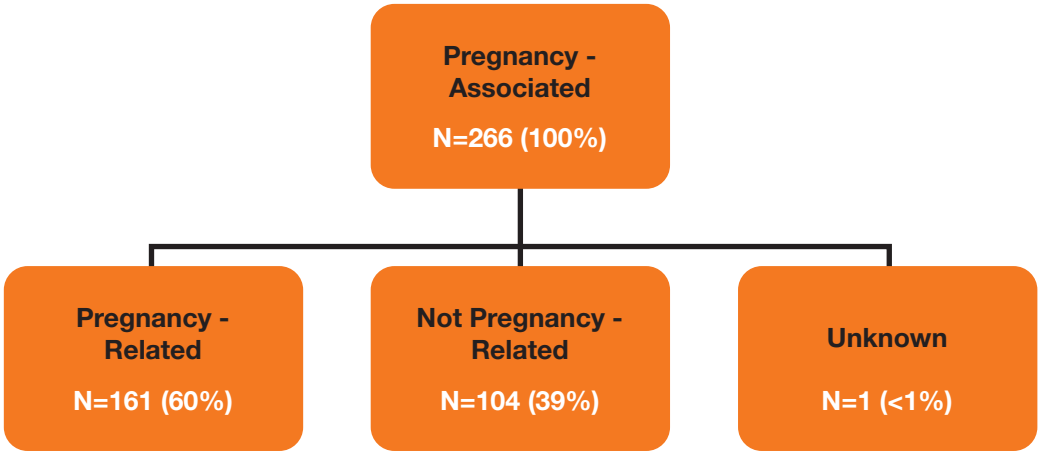
	1900	1920	1940	1960	1980	2000	2005
US	850.0	799.1	376.0	37.1	9.2	9.8	15.1
NYC	538.0	487.9	363.2	69.2	38.3	23.9	17.1

Table A-2:
US and NYC Maternal Mortality Ratios, 2001–2005*

	2001	2002	2003	2004	2005	2001–2005
US	9.9	8.9	12.1	13.1	15.1	11.8
NYC	33.1	25.2	17.7	22.6	17.1	23.1
Healthy People 2010 Goal	4.3	4.3	4.3	4.3	4.3	4.3

* These data were taken from published US and NYC maternal mortality data derived from standard surveillance methods.

Figure A-2:
BMIRH Classification of Pregnancy-Associated Deaths* in NYC, 2001–2005



* A **pregnancy-associated death** is one from any cause while pregnant or within one year of the end of pregnancy. A **pregnancy-related death** is the death of a woman while pregnant or within one year of the end of pregnancy from any cause related to or aggravated by the pregnancy or its management. Deaths categorized as **not pregnancy-related** occur within one year of pregnancy or the end of pregnancy, but are not causally related to pregnancy. See **Methods** and **Technical Appendix**.

Figure A-3:
Maternal Mortality Ratios (MMR) by Classification of Death, NYC, 2001–2005

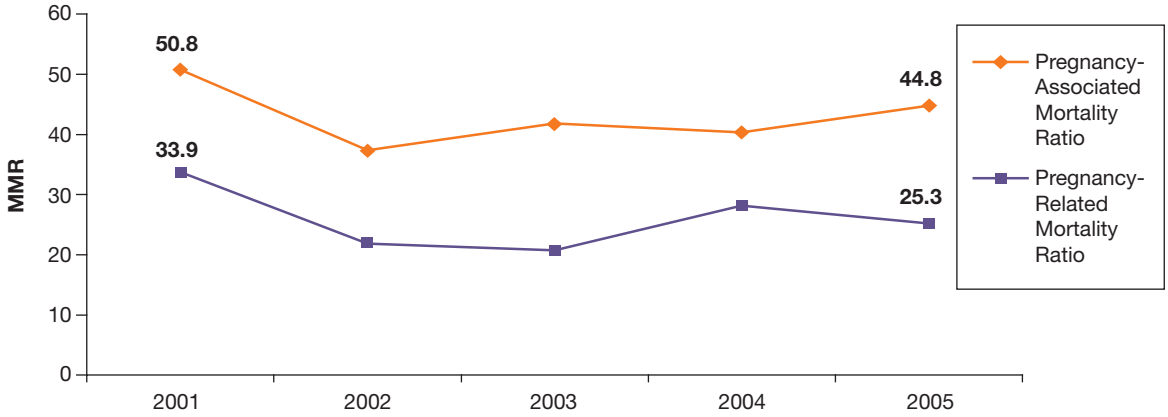


Table A-3:
Mortality Ratios by Classification of Death, NYC, 2001–2005

	2001	2002	2003	2004	2005	2001–2005
Pregnancy-Associated Mortality Ratio	50.8	37.4	41.8	40.3	44.8	43.0
Pregnancy-Related Mortality Ratio	33.9	22.0	20.9	28.2	25.3	26.0

Key Findings: Demographic Characteristics of Pregnancy-Related Deaths

Race/Ethnicity

- Black, non-Hispanic women comprised a disproportionately high percentage of pregnancy-related deaths (58%) relative to live births (24%). By contrast, 10% of pregnancy-related deaths and 30% of live births were to white, non-Hispanic women during these years. (Figure B-1a, Table B-1)
- The average PRMR was highest among black, non-Hispanic women, and was seven times higher than that of white, non-Hispanic women (61.7 vs. 8.6). (Figure B-1b, Table B-1)
- The average PRMR was two times higher for Hispanic and Asian/Pacific Islander women than for white, non-Hispanic women (19.1 and 17.5, respectively, vs. 8.6). (Figure B-1b, Table B-1)
- The average PRMR for black, non-Hispanic women was four times higher than for all other women (61.7 vs. 14.6). [Data for the average PRMR for all other women not shown.]

Maternal Age

- The PRMR increased with increasing maternal age. (Figure B-2a, Table B-2)
- The PRMR for women age 35 and older was nearly twice as high as that for women under 35 (38.4 vs. 23.0). However, this figure was driven by the PRMR for women 40 and older, which was two-and-a-half times that of women under 40. (Figure B-2b, Figure B-2c, Table B-2)

Place of Residence

- The PRMR was highest in the Bronx and Brooklyn (34.1 and 31.1, respectively) and lowest in Manhattan (14.0) and for non-resident women (19.6). (Figure B-3, Table B-3)
- The PRMR was highest in Northeast Bronx (57.8), South Bronx (41.7), Bedford Stuyvesant/Crown Heights (66.5), Flatbush (55.9), Canarsie (47.9), Jamaica (64.1), Southeast Queens (54.3), and Rockaway (47.4). (Figure B-4, Table B-4)

Nativity

- The pregnancy-related mortality ratio for US-born and foreign-born women (27.2 vs. 25.6, respectively) did not differ. (Figure B-5, Table B-5)

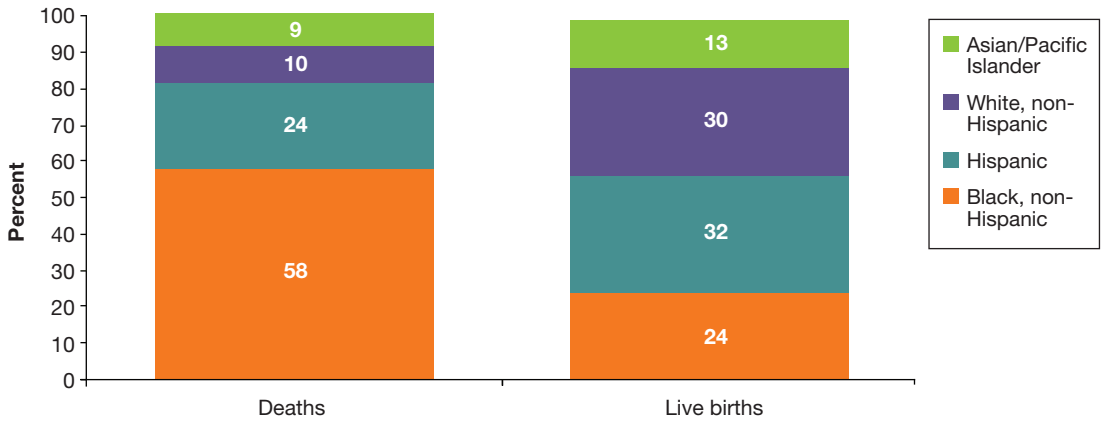
Insurance Coverage

- The PRMR for women with no insurance was about four times higher than for women with HMO/other third party insurance (71.9 vs. 18.4). (Figure B-6, Table B-6)
- The PRMR for women insured by Medicaid was comparable to the PRMR for women with private insurance (20.7 vs. 18.4). (Figure B-6, Table B-6)

Education Level

- The PRMR was highest among women who had graduated from high school but had no higher education (41.8). (Figure B-7, Table B-7)

Figure B-1a:
Pregnancy-Related Deaths and Live Births by Race/Ethnicity, NYC, 2001–2005*



* Percent totals may not equal 100% due to rounding.

Figure B-1b:
Pregnancy-Related Mortality Ratios (PRMR) by Race/Ethnicity, NYC, 2001–2005

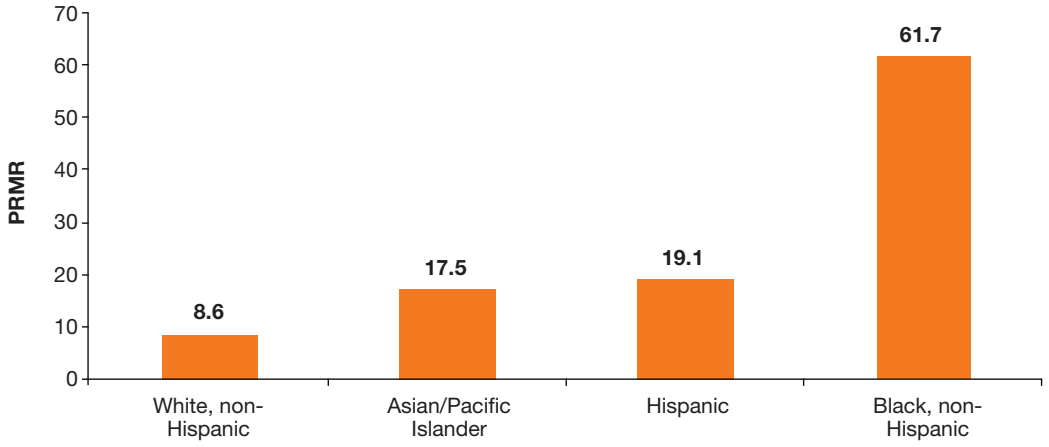


Table B-1:
Pregnancy-Related Deaths, Live Births, and Pregnancy-Related Mortality Ratios (PRMR) by Race/Ethnicity, NYC, 2001–2005

Race/Ethnicity	Pregnancy-Related Deaths		Live Births		PRMR	(95% CI)
	N	%	N	%		
Black, non-Hispanic	93	57.8	150,843	24.4	61.7	(49.8, 75.5)
White, non-Hispanic	16	9.9	186,043	30.1	8.6	(3.9, 16.3)
Hispanic	38	23.6	199,161	32.2	19.1	(13.5, 26.2)
Asian/Pacific Islander	14	8.7	79,778	12.9	17.5	(9.6, 29.4)
Other and unknown	0	0.0	2,304	0.4		
Total	161	100.0	618,129	100.0	26.0	(22.0, 30.0)

Figure B-2a:
Pregnancy-Related Mortality Ratios (PRMR) by Maternal Age, NYC, 2001–2005

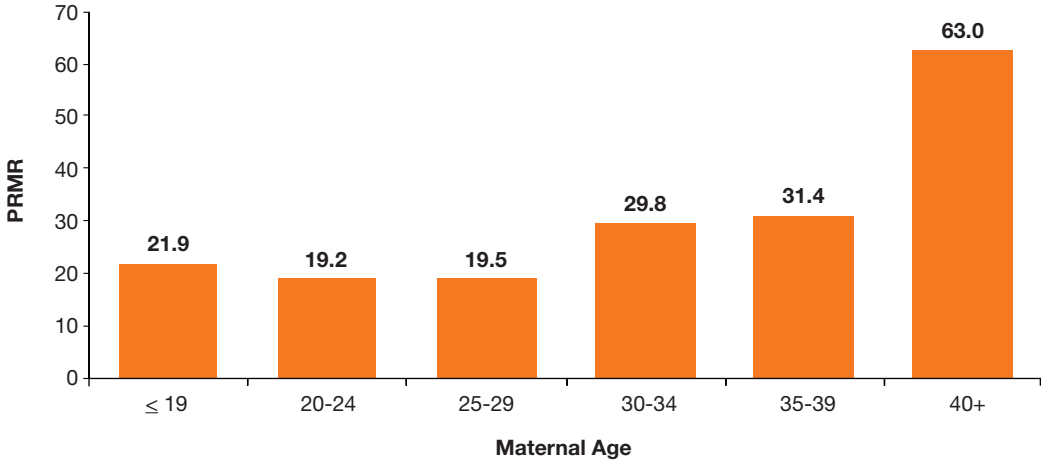


Figure B-2b:
Pregnancy-Related Mortality Ratios (PRMR) for Women Under 35 Years of Age and Women 35 Years and Older, NYC, 2001–2005

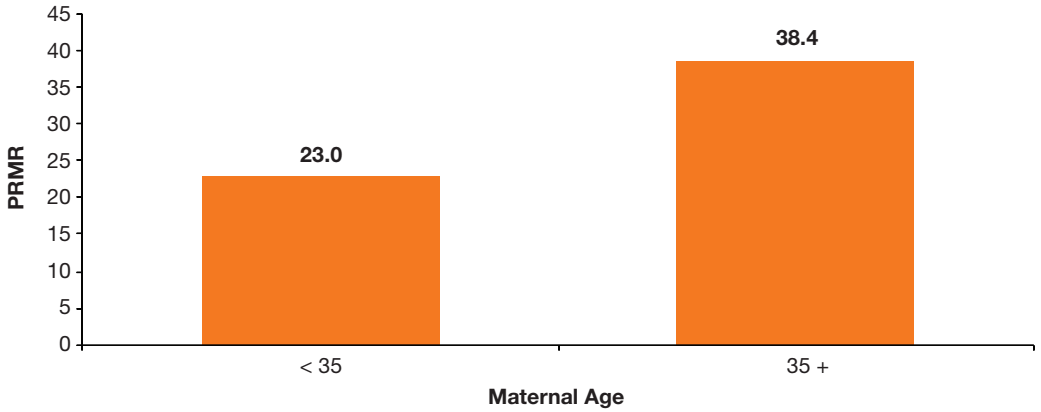


Figure B-2c:
Pregnancy-Related Mortality Ratios (PRMR) for Women Under 40 Years of Age and Women 40 Years and Older, NYC, 2001–2005

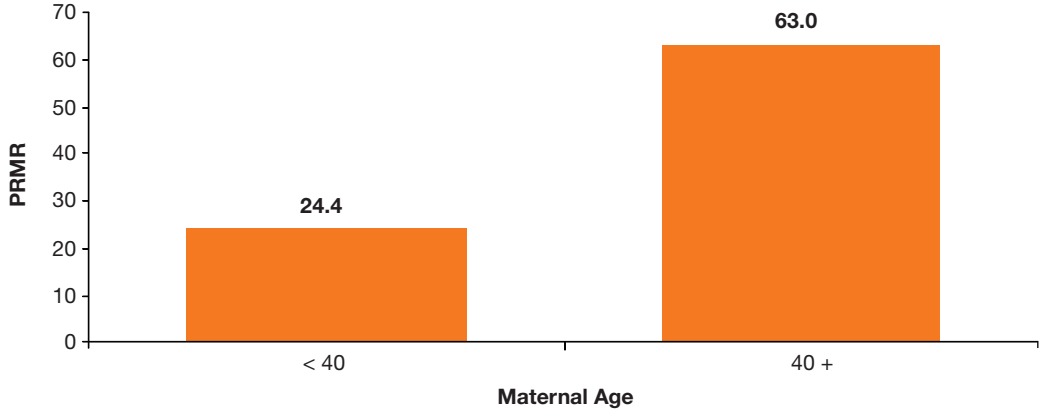


Table B-2:
Pregnancy-Related Deaths, Live Births, and Pregnancy-Related Mortality Ratios (PRMR) by Maternal Age, NYC, 2001–2005

Maternal Age	Pregnancy-Related Deaths		Live Births		PRMR	(95% CI)
	N	%	N	%		
≤19	10	6.2	45,738	7.4	21.9	(10.5, 40.2)
20-24	25	15.5	129,961	21.0	19.2	(12.4, 28.4)
25-29	31	19.3	158,686	25.7	19.5	(13.3, 27.7)
30-34	48	29.8	161,216	26.1	29.8	(22.0, 39.5)
35-39	30	18.6	95,524	15.5	31.4	(21.2, 44.8)
40+	17	10.6	26,998	4.4	63.0	(36.7, 100.8)
Unknown	0	0.0	6	0.0		
Total	161	100.0	618,129	100.0	26.0	(22.0, 30.0)
<35	114	70.8	495,601	80.2	23.0	(18.8, 27.2)
35+	47	29.2	122,522	19.8	38.4	(28.2, 51.0)
<40	144	89.4	591,125	95.6	24.4	(20.4, 28.4)

Figure B-3:
Pregnancy-Related Mortality Ratios (PRMR) by Maternal Borough of Residence, NYC, 2001–2005

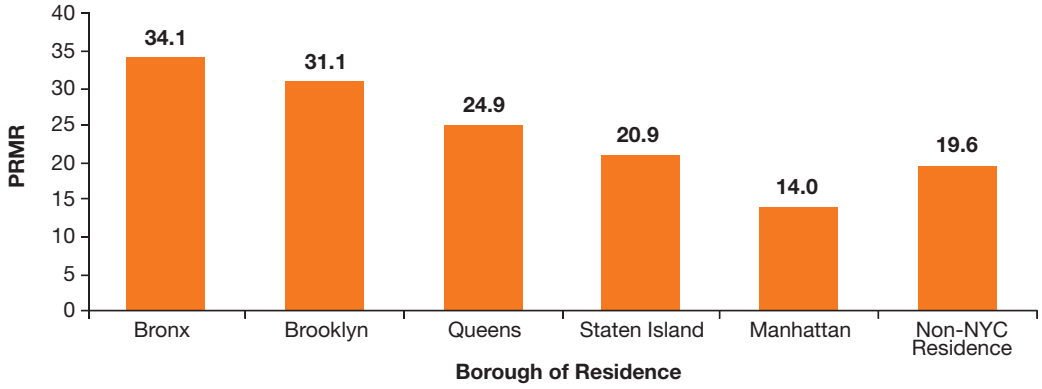
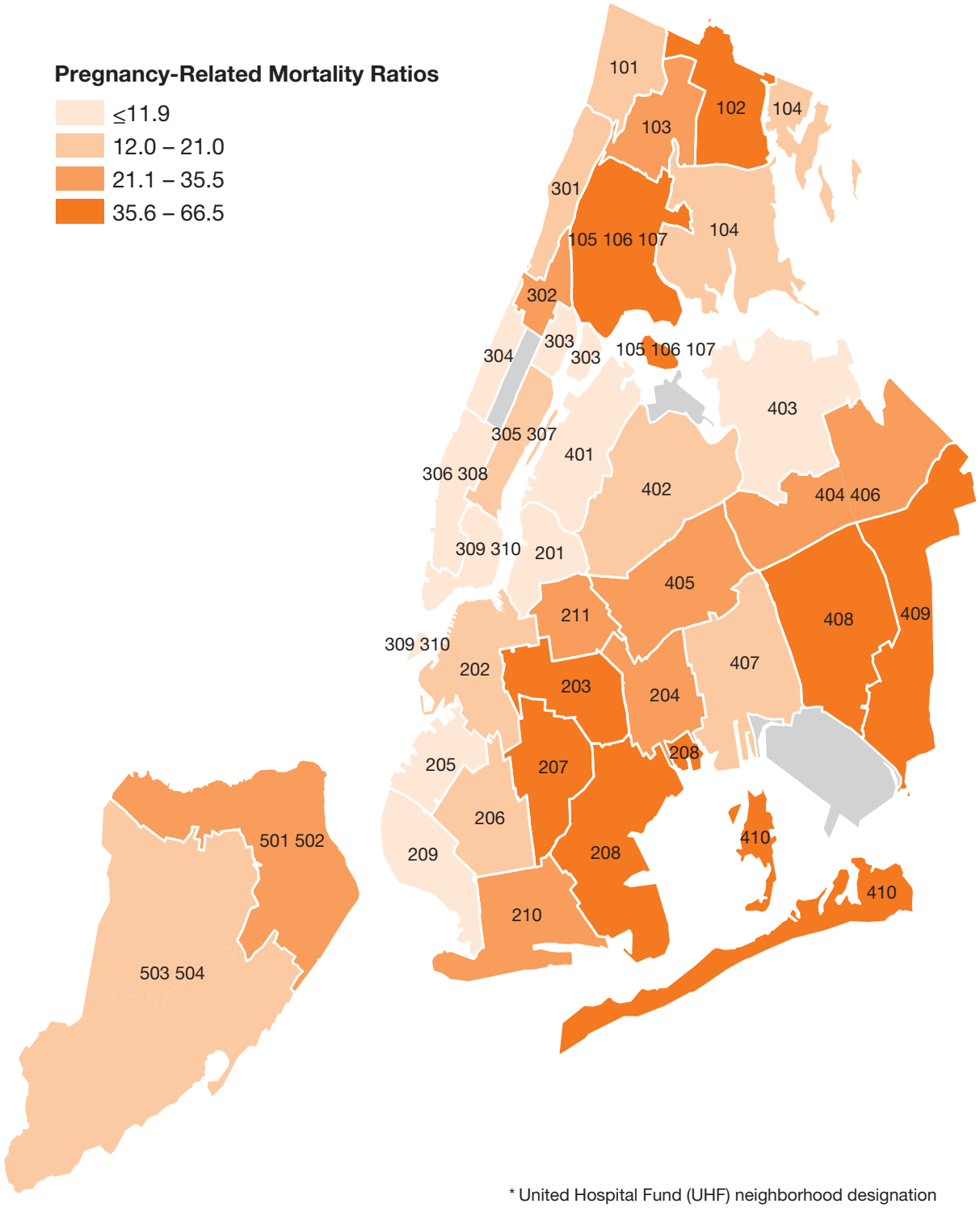


Table B-3:
Pregnancy-Related Deaths, Live Births, and Pregnancy-Related Mortality Ratios (PRMR), by Maternal Borough of Residence, NYC, 2001–2005

Borough of Residence	Pregnancy-Related Deaths		Live Births		PRMR	(95% CI)
	N	%	N	%		
Manhattan	14	8.7	100,119	16.2	14.0	(7.6, 23.5)
Bronx	36	22.4	105,683	17.1	34.1	(23.9, 47.2)
Brooklyn	61	37.9	196,347	31.8	31.1	(23.8, 39.9)
Queens	34	21.1	136,305	22.1	24.9	(17.3, 34.9)
Staten Island	6	3.7	28,713	4.6	20.9	(7.7, 45.5)
Non-residents	10	6.2	50,935	8.2	19.6	(9.4, 36.1)
Unknown	0	0.0	27	0.0		
Total	161	100.0	618,129	100.0	26.0	(22.0, 30.0)

Figure B-4:
NYC Pregnancy-Related Mortality Ratios by United Hospital Fund* (UHF) Neighborhood, NYC, 2001–2005



* United Hospital Fund (UHF) neighborhood designation is for the decedent's usual place of residence

Table B-4:
Pregnancy-Related Mortality Ratios by United Hospital Fund* Neighborhood, NYC, 2001–2005

United Hospital Fund Neighborhood	Pregnancy-Related Mortality Ratio
101 Kingsbridge	20.9
102 Northeast Bronx	57.8
103 Fordham-Bronx Park	23.0
104 Pelham-Throgs Neck	15.9
105/106/107 South Bronx	41.7
201 Greenpoint	8.6
202 Downtown-Heights-Slope	21.0
203 Bedford Stuyvesant-Crown Heights	66.5
204 East New York	33.2
205 Sunset Park	7.4
206 Borough Park	12.7
207 Flatbush	55.9
208 Canarsie	47.9
209 Bensonhurst	0.0
210 Coney Island	23.2
211 Williamsburg-Bushwick	32.9
301 Washington Heights	19.6
302 Central Harlem	35.5
303 East Harlem	11.9
304 Upper West Side	6.9
305/307 Upper East Side-Gramercy	15.1
306/308 Chelsea-Village	0.0
309/310 Union Square-Lower Manhattan	6.7
401 Long Island City-Astoria	7.8
402 West Queens	13.5
403 Flushing	0.0
404/406 Bayside Little Neck-Fresh Meadows	24.8
405 Ridgewood	21.2
407 Southwest Queens	16.9
408 Jamaica	64.1
409 Southeast Queens	54.3
410 Rockaway	47.4
501/502 Northern Staten Island	30.1
503/504 Southern Staten Island	13.0

* United Hospital Fund areas are based on groupings of zip codes.

Figure B-5:
Pregnancy-Related Mortality Ratios (PRMR) by Maternal Nativity, NYC, 2001–2005

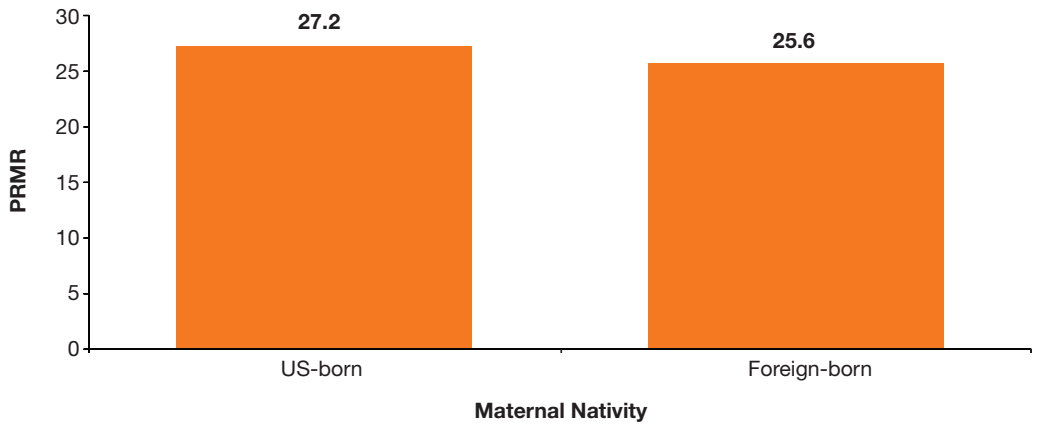


Table B-5:
Pregnancy-Related Deaths, Live Births, and Pregnancy-Related Mortality Ratios (PRMR) by Nativity, NYC, 2001–2005

Nativity	Pregnancy-Related Deaths		Live Births		PRMR	(95% CI)
	N	%	N	%		
US-born	77	47.8	283,228	45.8	27.2	(21.5, 34.0)
Foreign-born	82	50.9	320,652	51.9	25.6	(20.4, 31.8)
US territories	1	0.6	11,198	1.8	8.9	(0.2, 49.6)
Unknown	1	0.6	3,051	0.5		
Total	161	100.0	618,129	100.0	26.0	(22.0, 30.0)

Figure B-6:
Pregnancy-Related Mortality Ratios (PRMR) by Insurance Type, NYC, 2001–2005

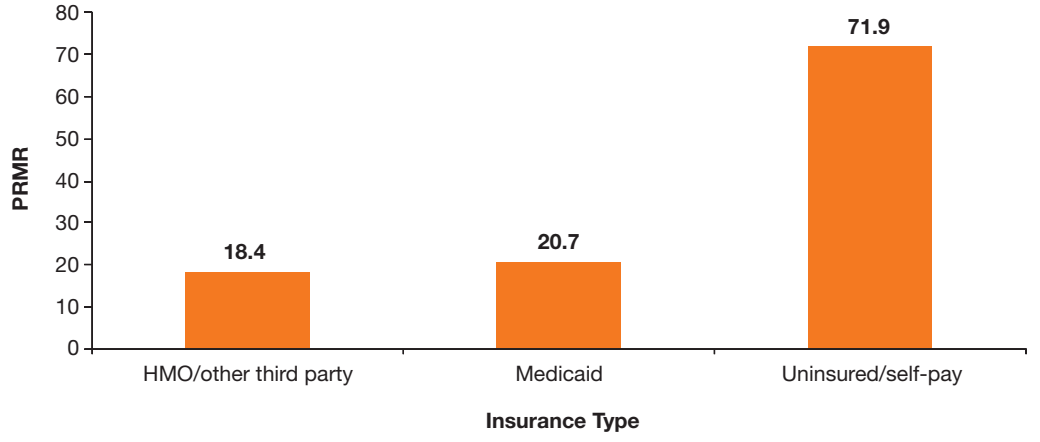


Table B-6:
Pregnancy-Related Deaths, Live Births, and Pregnancy-Related Mortality Ratios (PRMR) by Insurance Type, NYC, 2001–2005

Insurance Type	Pregnancy-Related Deaths		Live Births		PRMR	(95% CI)
	N	%	N	%		
Uninsured/self-pay	11	6.8	15,308	2.5	71.9	(35.9, 128.6)
Medicaid	66	41.0	318,815	51.6	20.7	(16.0, 26.3)
HMO/other third party	52	32.3	283,154	45.8	18.4	(13.7, 24.1)
Unknown	32	19.9	852	0.1		
Total	161	100.0	618,129	100.0	26.0	(22.0, 30.0)

Figure B-7:
Pregnancy-Related Mortality Ratios (PRMR) by Maternal Education, NYC, 2001–2005

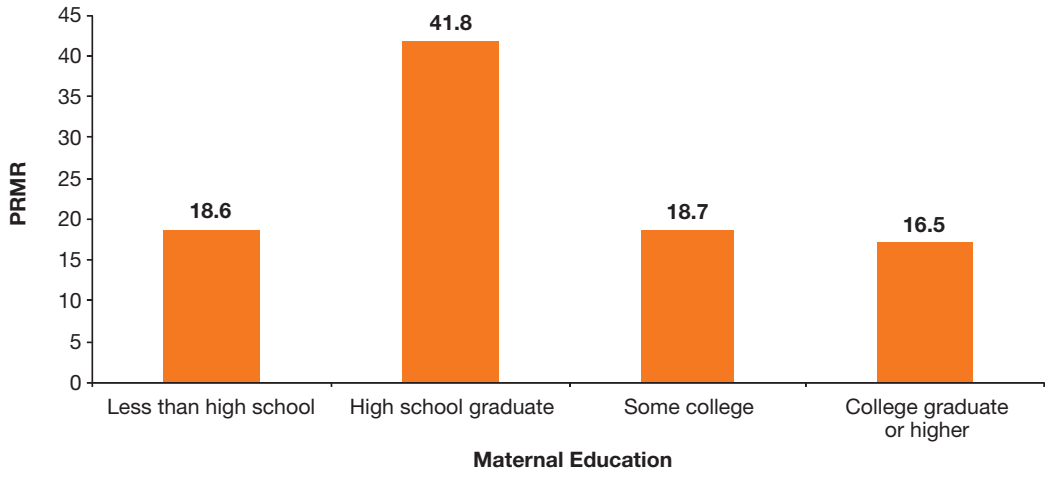


Table B-7:
Pregnancy-Related Deaths, Live Births, and Pregnancy-Related Mortality Ratios (PRMR) by Maternal Education, NYC, 2001–2005

Education Level	Pregnancy-Related Deaths		Live Births		PRMR	(95% CI)
	N	%	N	%		
Less than high school	26	16.1	139,759	22.6	18.6	(12.2, 27.3)
High school graduate	79	49.1	188,895	30.6	41.8	(33.1, 52.1)
Some college	22	13.7	117,676	19.0	18.7	(11.7, 28.3)
College graduate or higher	28	17.4	169,281	27.4	16.5	(11.3, 24.6)
Unknown	6	3.7	2,518	0.4		
Total	161	100.0	618,129	100.0	26.0	(22.0, 30.0)

Key Findings: Antepartum and Delivery Characteristics

Obesity by Race

- Overall, 49.1% of women who died of pregnancy-related causes were obese.(Table C-1)
- Obesity was more common among black, non-Hispanic women (60.2%) and white, non-Hispanic women (43.7%) who died of pregnancy-related causes than among Hispanic (34.2%) and Asian/Pacific Islander women (21.4%). Black, non-Hispanic women were significantly more likely to be obese than both Hispanic and Asian/Pacific Islander women. The differences between all other groups were not statistically significant. (Figure C-1, Table C-1)

Obesity by Parity

- Obesity increased with parity; however, the differences were not statistically significant. (Figure C-2, Table C-2)
- Of the women who had two or more previous live births, almost 61% were documented as obese compared with 41% of women who were having their first delivery. (Figure C-2, Table C-2)

Preexisting Health Conditions

- Overall, more than half (55.9%) of women who died of pregnancy-related causes had at least one preexisting chronic health condition. (Table C-3)
- Asian/Pacific Islander women were less likely to have a preexisting chronic health condition (28.6%) compared to all other women. (Figure C-3, Table C-3)
- Hypertension (13.0%), asthma (11.8%), and cardiac conditions (10.6%) were the most common preexisting health conditions among women who died of pregnancy-related causes. (Data not shown)

Pregnancy Outcomes

- Among women who died of pregnancy-related causes, the majority (70.8%) had a live birth, primarily of a single infant (93.8%). (Table C-4) A live birth was the most common pregnancy outcome for women in all age groups and race/ethnicities. (Data not shown)

Select Characteristics of Pregnancy-Related Deaths

- Among women who died of pregnancy-related causes and had a live birth or stillbirth (Table C-5):
  - 79% were delivered by cesarean section
  - 50% were delivered at term (37+ weeks)
  - 53% initiated care in the first trimester (for 24%, the trimester of prenatal care initiation was unknown)
  - 51% had *adequate* or *adequate plus* prenatal care (for 26%, adequacy of prenatal care was unknown)
  - 60% of women had a previous live birth

Gestational Age at Delivery by Race

- Among women who died of pregnancy-related causes, black, non-Hispanic and Hispanic women were more likely to deliver at term (50.7% and 57.1%, respectively) as compared to white (33.3%) and Asian/Pacific Islander women (44.4%). These differences were not statistically significant. (Figure C-4, Table C-6)

Figure C-1:
Percent of Pregnancy-Related Deaths to Obese Women by Race/Ethnicity, NYC, 2001–2005

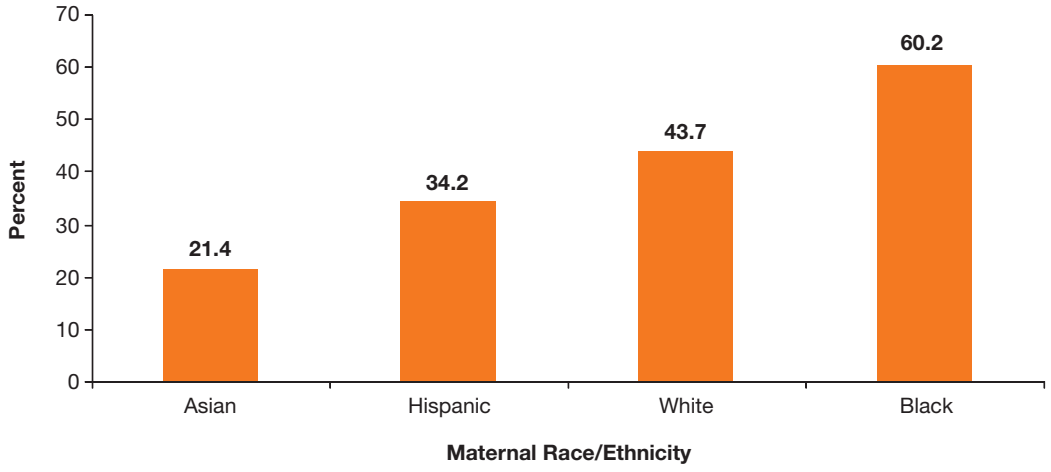


Figure C-2:
Percent of Pregnancy-Related Deaths to Obese Women by Parity, NYC, 2001–2005

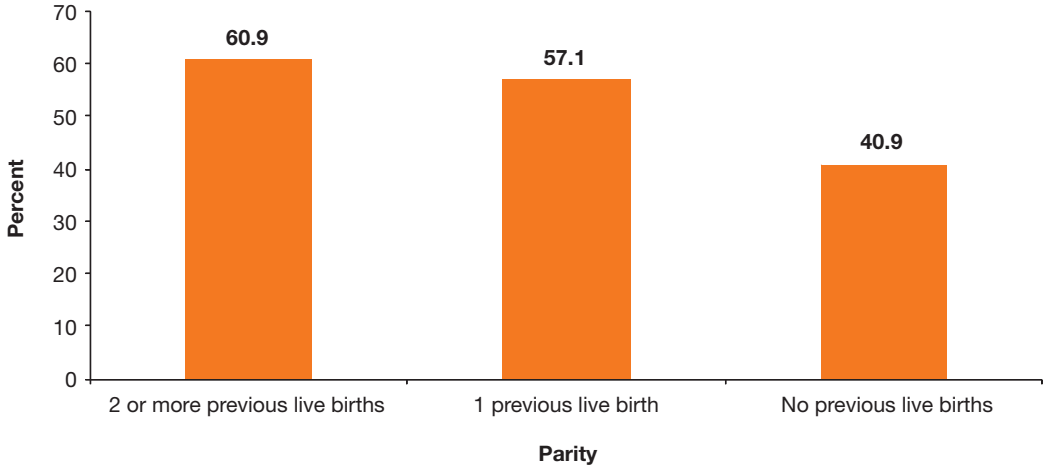


Table C-1:
Number and Percent of Pregnancy-Related Deaths to Obese Women by Race/Ethnicity, NYC, 2001–2005

Race/Ethnicity	Number of Obese Women	Number of Pregnancy-Related Deaths	Percent of Pregnancy-Related Deaths to Obese Women	(95% CI)
Black non-Hispanic	56	93	60.2	(50.1, 69.6)
White non-Hispanic	7	16	43.7	(21.2, 50.1)
Hispanic	13	38	34.2	(7.6, 47.6)
Asian and Pacific Islander	3	14	21.4	(41.5, 56.7)
Total	79	161	49.1	(23.1, 66.8)

Table C-2:
Number and Percent of Pregnancy-Related Deaths to Obese Women by Parity, NYC, 2001–2005

Parity	Number of Obese Women	Number of Pregnancy-Related Deaths	Percent of Pregnancy-Related Deaths to Obese Women	(95% CI)
No previous live births	18	44	40.9	(27.7, 55.6)
1 previous live birth	16	28	57.1	(39.1, 73.5)
≥2 previous live births	39	64	60.9	(48.7, 71.9)
Unknown	6	25		
Total*	79	161	49.1	(23.1, 66.8)

* Included in the denominator are seven women with unknown information on obesity that were recoded as not obese. Additionally, there were 25 women with missing information on parity who were also included in the denominator. The percentage of pregnancy-related deaths to obese women with unknown parity was not calculated.

Figure C-3:
Percent of Pregnancy-Related Deaths to Women with Preexisting Chronic Conditions by Race/Ethnicity, NYC, 2001–2005

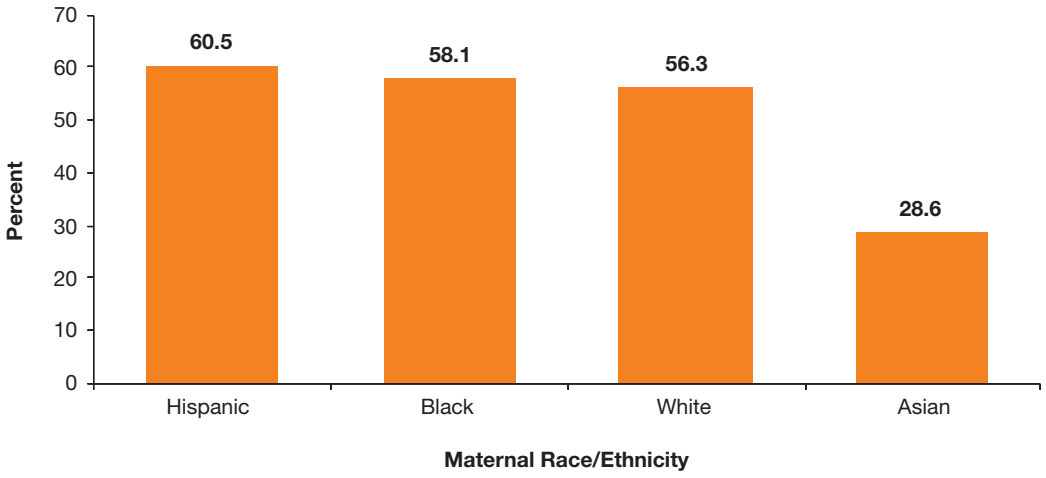


Table C-3:
Number and Percent of Pregnancy-Related Deaths to Women with Preexisting Chronic Conditions* by Race/Ethnicity, NYC, 2001–2005

Race/Ethnicity	Number of Pregnancy-Related Deaths to Women with at Least 1 Chronic Condition	Total Number of Pregnancy-Related Deaths‡	Percent of Pregnancy-Related Deaths to Women with at Least 1 Chronic Condition	(95% CI)
Black non-Hispanic	54	93	58.1	(33.2, 76.9)
White non-Hispanic	9	16	56.3	(47.9, 67.6)
Hispanic	23	38	60.5	(44.7, 74.4)
Asian/Pacific Islander	4	14	28.6	(11.7, 54.6)
Total	90	161	55.9	(48.2, 63.3)

* Chronic conditions include: psychiatric disorders, type I and II diabetes, thyroid disorders, other endocrine disorders, HIV/AIDS, tuberculosis, asthma, other pulmonary disorders, congenital heart disease, hypertension, cardiac conditions, epilepsy/seizure disorders, other neurologic disorders, hepatitis, sickle cell disease, iron deficiency anemia, coagulation disorders, other hematologic disorders, and renal disease.
‡Included in the denominator are 22 women with unknown information on chronic conditions that were recoded as not having a chronic condition.

Table C-4:
Distribution of Pregnancy-Related Deaths by Pregnancy Outcome, NYC, 2001–2005

Pregnancy Outcome	Number	Percent
Undelivered	23	14.3
Live delivery, singleton	107	66.5
Live delivery, multiple	6	3.7
Live delivery and stillbirth	1	0.6
Stillborn (>23wks)	7	4.3
Spontaneous termination of pregnancy	4	2.5
Induced termination of pregnancy	7	4.3
Ectopic Pregnancy	4	2.5
Molar Pregnancy	1	0.6
Unknown	1	0.6
Total	161	100*

* Percent totals may not equal 100% due to rounding.

Table C-5:
Antepartum and Delivery Characteristics for Pregnancy-Related Deaths (live births and stillbirths only, n=121), NYC, 2001–2005

	Number	Percent
Delivery Type		
Cesarean section	96	79
Vaginal	23	19
Unknown	2	2
Estimated Gestational Age at Delivery		
<28 weeks	12	10
28–33 weeks	26	21
34–36 weeks	18	15
37–41 weeks	60	50
Unknown	5	4
Trimester of Prenatal Care Initiation		
No prenatal care	2	2
First trimester	64	53
Second trimester	20	16
Third trimester	6	5
Unknown	29	24
Adequacy of Prenatal Care*		
Inadequate	20	17
Intermediate	7	6
Adequate	30	25
Adequate plus	32	26
Unknown	32	26
Parity		
No previous live births	40	33
1 previous live birth	22	18
>2 previous live births	51	42
Unknown	8	7

* See **Technical Appendix** for description of "Adequacy of prenatal care."

Figure C-4:
Gestational Age at Delivery by Maternal Race/Ethnicity for Pregnancy-Related Deaths (live births and stillbirths only, n=121), NYC, 2001–2005

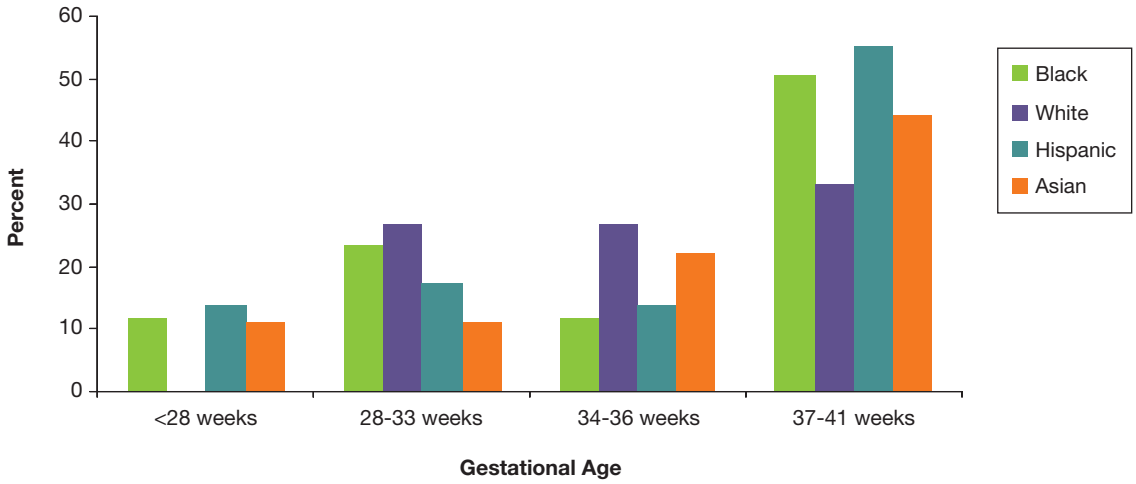


Table C-6:
Gestational Age at Delivery by Race/Ethnicity for Pregnancy-Related Deaths (live births and stillbirths only, n=121), NYC, 2001–2005*

	<28 weeks		28–33 weeks		34–36 weeks		37–41 weeks	
Race/Ethnicity	N	%	N	%	N	%	N	%
Black non-Hispanic	8	11.6	16	23.2	8	11.6	35	50.7
White non-Hispanic	0	0	4	26.7	4	26.7	5	33.3
Hispanic	3	10.7	5	17.9	4	14.3	16	57.1
Asian/Pacific Islander	1	11.1	1	11.1	2	22.2	4	44.4
Total	12	9.9	26	21.5	18	14.9	60	49.6

* There are five women with unknown gestational ages at delivery that were included in the denominator when calculating percents but were omitted from the table.

Key Findings: Location and Timing of Death

Place of Death

- 80.2% of all pregnancy-related deaths that resulted in a live birth or stillbirth occurred at either a Regional Perinatal Center or a Level III obstetric facility. (Figure D-1, Table D-1)

Timing of Death

- 67% of all pregnancy-related deaths occurred either antepartum or within one week of delivery, with 33.5% occurring within one day of delivery. (Figure D-2, Table D-2)

Figure D-1:
Location of Death for Pregnancy-Related Deaths (live births and stillbirths only, n=121), NYC, 2001–2005

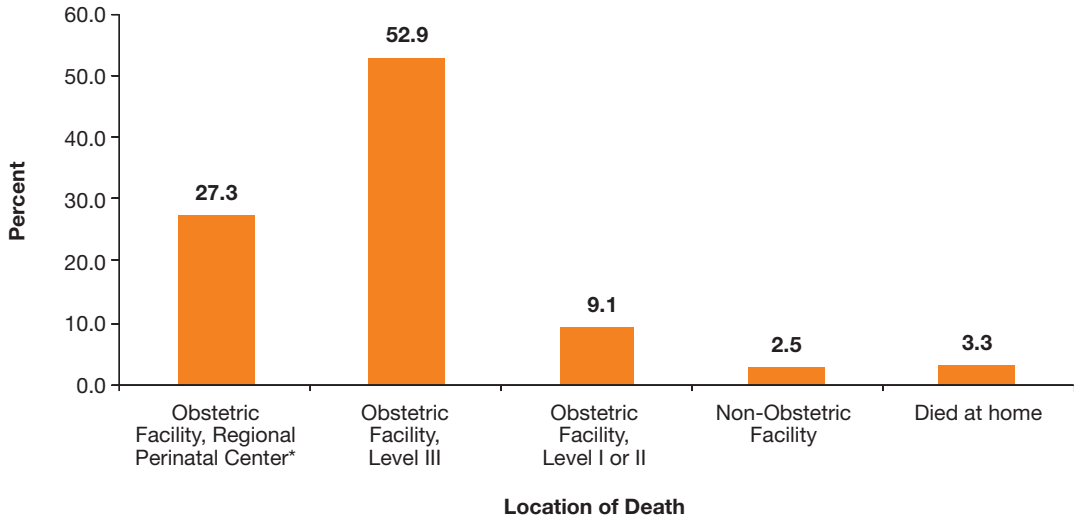


Table D-1:
Location of Death for Pregnancy-Related Deaths (live births and stillbirths only, n=121), NYC, 2001–2005

	Number	Percent
Obstetric Facility, Regional Perinatal Center*	33	27.3
Obstetric Facility, Level III	64	52.9
Obstetric Facility, Level I or II	11	9.1
Non-Obstetric Facility	3	2.5
Died at home	4	3.3
Unknown	6	4.9
Total	121	100.0

* A Regional Perinatal Center is designated by the NY State Department of Health as a level IV hospital that serves a specific geographic region and provides all aspects of obstetrics and neonatal services, including those for high-risk mothers and babies.

Figure D-2:
Interval from End of Pregnancy to Death for Pregnancy-Related Deaths, NYC, 2001–2005

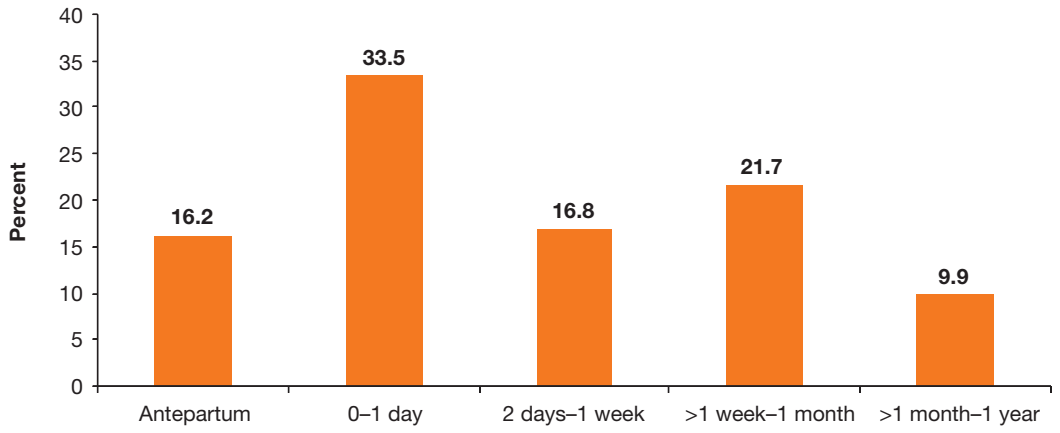


Table D-2:
Interval from End of Pregnancy to Death for Pregnancy-Related Deaths, NYC, 2001–2005

Interval	Number	Percent
Antepartum	26	16.2
0–1 day	54	33.5
2 days–1 week	27	16.8
>1 week–1 month	35	21.7
>1 month–1 year	16	9.9
Unknown	3	1.9
Total	161	100

Key Findings: Causes of Death

Causes of Death

- The leading causes of pregnancy-related death were embolism (17.4%), hemorrhage (16.8%), pregnancy-induced hypertension (14.3%), and infection (14.3%). Together, these causes accounted for 63% of all pregnancy-related deaths. (Table E-1, Table E-2)
- Within the "Other cause of death" category, cardiac conditions were most common and accounted for 18.6% of all pregnancy-related deaths. (Table E-2)

Selected Characteristics for the Leading Causes of Pregnancy-Related Deaths (Table E-3)

- Black, non-Hispanic women had the highest percentage of deaths for all four leading causes of pregnancy-related deaths; 82% of all embolism deaths and 65% of deaths due to pregnancy-induced hypertension occurred among these women.
- Women aged 30–39 had the highest percentage of deaths due to hemorrhage, infection, and pregnancy-induced hypertension.
- For all four leading causes of pregnancy-related death, cesarean section was the most common mode of delivery and a live birth was the most common pregnancy outcome.
- Among women who died from embolism, hemorrhage and infection, more than half were categorized as obese.
- 72% of embolism deaths and 81% of hemorrhage deaths occurred either antepartum or within one day of the end of pregnancy, compared to 26% and 39% of deaths due to infection and pregnancy-induced hypertension, respectively. Women who died from infection and pregnancy-induced hypertension were more likely to die between two days and one month following the end of pregnancy.
- Women with embolic disorders had a higher percentage of undelivered pregnancies than other leading causes of pregnancy-related death.

Table E-1:
Pregnancy-Related Deaths by Cause of Death,* NYC, 2001–2005

Cause of Death	Number	Percent
Embolism	28	17.4
Hemorrhage	27	16.8
Pregnancy-induced hypertension	23	14.3
Infection	23	14.3
Cancer	4	2.5
Anesthesia complications	3	1.9
Injury	3	1.9
Other cause of death	50	31.1
Total	161	100‡

* Cause of death as assigned by physician after review of all records (death certificate, medical record and autopsy report) for each death and is based on the CDC's National Pregnancy Mortality Surveillance Coding Manual cause of death categories.
‡Percent totals may not equal 100% due to rounding.

Table E-2:
Detailed Cause of Death for Pregnancy-Related Deaths, NYC, 2001–2005

Cause of Death	Number of Deaths	Percent
Embolism	**28**	**17**
Venous thromboembolism	24	15
Amniotic fluid embolism	4	2
Hemorrhage	**27**	**17**
Post-cesarean hemorrhage	5	3
Placenta accreta, increta, percreta	4	2
Ruptured ectopic pregnancy	4	2
Uterine atony	4	2
Coagulopathy	3	2
Uterine rupture	2	1
Placenta abruptio	2	1
Other	2	1
Placenta previa	1	1
Infection	**23**	**14**
Sepsis	11	7
Pneumonia/influenza	9	6
Myocarditis	3	2
Pregnancy-induced hypertension (PIH)	**23**	**14**
Cancer	**4**	**3**
Injury	**3**	**2**
Anesthesia complications	**3**	**2**
Other cause of death	**50**	**31**
Cardiovascular problems	16	10
Cardiac arrest/failure, not otherwise specified	6	4
Cardiomyopathy	5	3
Intracerebral hemorrhage not associated with PIH	5	3
Pulmonary problems	5	3
Cardiac arrhythmia	3	2
Hematopoietic (e.g., sickle cell disease)	2	1
Neurologic/neurovascular problems	2	1
Multiple system organ failure, not otherwise specified	2	1
Other conditions not specified	2	1
Metabolic, not pregnancy-related	1	1
Immune deficiency problems	1	1

Table E-3:
Select Maternal and Antepartum/Delivery Characteristics for the Leading Causes of Pregnancy-Related Deaths, NYC, 2001–2005 (n=101)

	Embolism N=28		Hemorrhage N=27		Infection N=23		Pregnancy Induced Hypertension N=23	
	N	%	N	%	N	%	N	%
Race								
Black non-Hispanic	23	82	12	44	11	48	15	65
White non-Hispanic	0	0	2	7	3	13	1	4
Hispanic	4	14	9	33	6	26	5	22
Asian/Pacific Islander	1	4	4	15	3	13	2	9
Age								
≤19	1	4	2	7	4	17	2	9
20–29	12	42	6	22	8	35	6	26
30–39	10	36	15	56	10	43	10	43
40+	5	18	4	15	1	4	5	22
Type of Delivery								
Cesarean section	15	54	20	74	13	57	15	65
Vaginal	1	4	2	7	3	13	4	17
Undelivered/died pregnant	8	28	1	4	3	13	2	9
Not applicable	4	14	4	15	4	17	1	4
Unknown							1	4
Obesity								
No	11	40	12	44	10	44	13	57
Yes	16	57	15	56	13	57	8	35
Unknown	1	4	0	0	0	0	2	9
Pregnancy Outcome								
Undelivered	8	28	1	4	4	17	2	9
Live birth	16	57	21	77	14	61	17	74
Stillbirth or spontaneous termination of pregnancy	1	4	1	4	3	13	2	9
Induced termination of pregnancy	2	7	0	0	2	9	1	4
Other	1	4	4	15	0	0	1	4
Interval Between End of Pregnancy and Death								
Antepartum (died pregnant)	8	29	2	7	4	17	2	9
0–1 day	12	43	20	74	2	9	7	30
2 days–1 week	4	14	4	15	4	17	7	30
>1week–1 month	4	14	1	4	10	43	4	17
1 month–1 year	0	0	0	0	3	13	2	9
Unknown							1	4

Key Findings: Pregnancy-Associated Deaths Not Related to Pregnancy

Deaths Due to Injury

- Among deaths that were not pregnancy-related, injury was the leading cause of death (50%). (Table F-1)
- Homicide was the most common cause of pregnancy-associated deaths due to injury (44%). (Table F-1)

Injury Deaths Due to Homicide

- The pregnancy-associated homicide ratio was five times higher for black, non-Hispanic women (8.6) and two times higher for Hispanic women (3.5) as compared to white, non-Hispanic women (1.6). (Figure F-1, Table F-2)
- Cross-matching with the DOHMH's Injury Epidemiology Unit database for female homicide victims offered information regarding the relationship of the perpetrator to the victim; more than half (52%) of the pregnancy-associated homicide cases were linked to intimate partner violence. (Data not shown)

Table F-1:
Cause of Death for Pregnancy-Associated Deaths Not Related to Pregnancy, NYC, 2001–2005 (n=104)

Cause of Death	N	%
Injury	**52**	**50**
Homicide	23	22
Suicide	7	7
Substance abuse	8	8
Motor vehicle accident	8	8
Unintentional injury, non-specific	6	6
Embolism	**2**	**2**
Hemorrhage	**2**	**2**
Infection	**5**	**5**
Cancer	**15**	**14**
Other Cause of Death	**26**	**25**
Cardiovascular problems	4	4
Intracerebral hemorrhage not associated with PIH	5	5
Pulmonary problems	3	3
Hematopoietic (e.g., sickle cell disease)	2	2
Cardiac arrhythmia	5	5
Multiple system organ failure, not otherwise specified	1	1
Other conditions not specified	1	1
Metabolic, not pregnancy-related	2	2
Neurologic/neurovascular problems	2	2
Immune deficiency problems	1	1
Unknown	**2**	**2**

Figure F-1:
Pregnancy-Associated Deaths Due to Homicide by Race/Ethnicity, NYC, 2001–2005 (n=23)

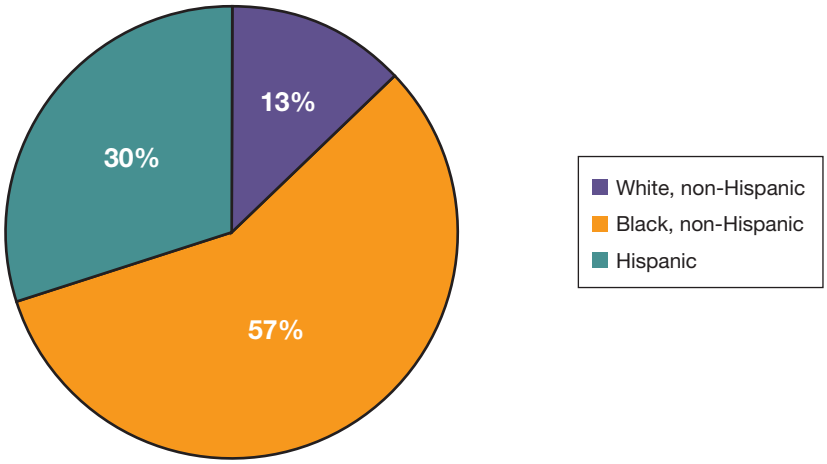


Table F-2:
Pregnancy-Associated Homicide Deaths: Number, Percent and Ratios by Race/Ethnicity, NYC, 2001–2005

Race/Ethnicity	Number	Percent	Pregnancy-Associated Homicide Ratio*	(95% CI)
Black, non-Hispanic	13	56.5	8.6	(4.6, 14.7)
White, non-Hispanic	3	13.0	1.6	(0.3, 4.7)
Hispanic	7	30.4	3.5	(1.4, 7.2)
Total	23	100.0	3.7	(2.3, 5.6)

* The pregnancy-associated homicide ratio is the number of pregnancy-associated homicide deaths per 100,000 live births.

Technical Appendix

Maternal mortality terminology

BMIRH uses the terminology established by the Maternal Mortality Study Group of the American College of Obstetricians and Gynecologists (ACOG) and the Centers for Disease Control and Prevention (CDC) to categorize deaths with a temporal relationship to pregnancy.[9]

Pregnancy-associated death is the death of a woman from any cause while pregnant or within one calendar year of the end of pregnancy. Pregnancy-associated deaths are further categorized based on whether they are causally related to the pregnancy. Deaths that occurred more than one year after the end of pregnancy and deaths to women who were determined not to have been pregnant within one year of death are not counted as pregnancy-associated deaths.

Maternal death, as used in this report, is synonymous with the term *pregnancy-associated death.*

Pregnancy-related death is defined as the death of a woman while pregnant or within one year of the end of pregnancy from any cause related to or aggravated by the pregnancy itself or its management. In these cases, the pregnancy and death are causally related.

Not pregnancy-related death is defined as a death that is temporally related to pregnancy (i.e., occurring within one year of pregnancy or the end of pregnancy) but which is not causally related to the pregnancy. These deaths include those due to accidents and homicides.

Maternal mortality ratio (MMR) is defined as the number of maternal deaths per 100,000 live births in a given year and is the metric for reporting maternal deaths used both nationally and internationally in official statistics. In this report, the MMR is synonymous with the pregnancy-associated mortality ratio (PAMR).

Pregnancy-related mortality ratio (PRMR) is defined as the number of pregnancy-related deaths per 100,000 live births and is the main indicator reported in the tables and figures in this report.

Pregnancy-associated homicide is defined as a pregnancy-associated death that was due to homicide.

Pregnancy-associated homicide ratio is defined as the number of pregnancy-associated homicide deaths per 100,000 live births.

Other definitions

Race/Ethnicity is based on that of the mother and is taken from the death certificate (for the numerator) and the birth certificate (for the denominator) when calculating MMRs.

Maternal age is based on age at death and is grouped in either 5-year or 10-year intervals, with ≤19 and 40+ as the lower and upper categories.

Place of residence is the decedent's usual residence around the time of death and typically correlates with that listed on the maternal death certificate.

Education information is based on total years of education completed at the time of death as listed on the death certificate.

Technical Appendix *(continued)*

Adequacy of prenatal care was evaluated using the Kotelchuck Index.[10] The Kotelchuck Index compares the actual number of prenatal visits to the expected number of visits, which is based on the month prenatal care began and the total number of prenatal visits recommended by ACOG for each month of pregnancy. Care is categorized as inadequate if a woman made less than 50% of expected visits, intermediate if she made between 50% and <80% of visits, adequate if she received between 80% and <110% of visits, and adequate plus if she made 110% or more of expected visits. If care began after the fourth month of pregnancy, it was classified as inadequate regardless of the number of subsequent visits. If there was insufficient data to calculate prenatal care adequacy, the case was listed as unknown.

Obesity is defined as a BMI ≥30 (based on height and pre-pregnancy weight information in the medical records). Individuals were also categorized as obese if a clinical note in the chart indicated the presence of that condition.

Gestational age was based on either the time between the last menstrual period and the time the pregnancy ended or the clinical estimate of gestational age at the time the pregnancy ended.

Data quality issues

Ratios based on small numbers

Pregnancy-associated deaths are rare events. The CDC's National Center for Health Statistics does not publish or release rates based on fewer than 20 observations due to the lack of reliability of estimates based on small numbers; however, pregnancy-related mortality ratios that are based on fewer than 20 deaths are presented in this report and should therefore be interpreted with caution. The 95% confidence intervals are presented for all reported pregnancy-related mortality ratios. The difference between two ratios is statistically significant if the confidence intervals do not overlap.[11]

Missing information

Some records were not complete and were missing demographic and other data. The percent of missing values ranged from 0% for demographic variables such as race/ethnicity and age to 27% for adequacy of prenatal care initiation.

Cases with missing information on obesity or chronic conditions were recoded as "not obese" or "not having a chronic condition," respectively.

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