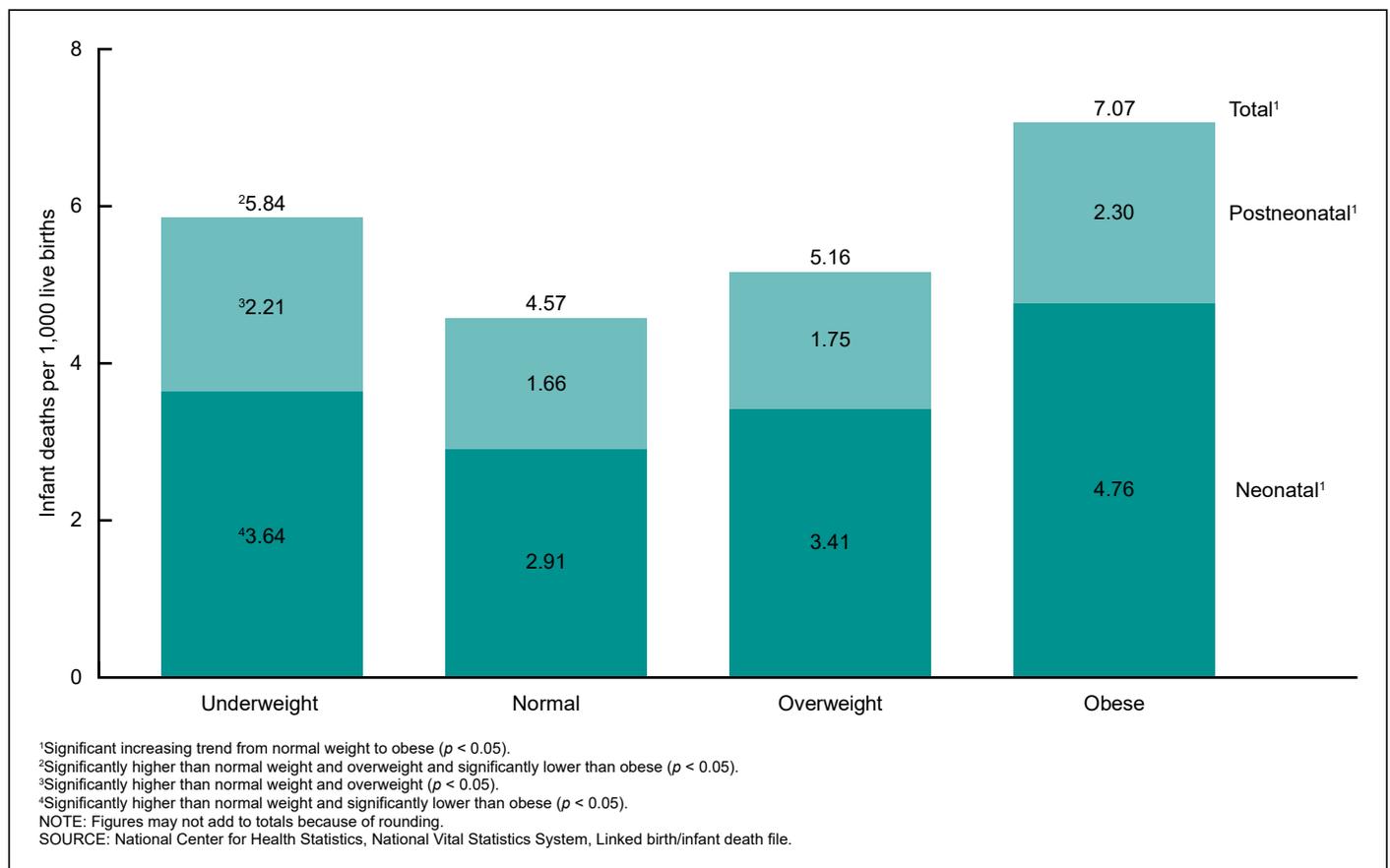# Infant Mortality by Maternal Prepregnancy Body Mass Index: United States, 2017–2018

by Danielle M. Ely, Ph.D., Elizabeth C.W. Gregory, M.P.H., Division of Vital Statistics; and Patrick Drake, M.S., The Global Fund to Fight AIDS, Tuberculosis and Malaria

Abstract

Objective—This report presents 2017–2018 infant mortality rates in the United States by maternal prepregnancy body mass index, and by infant age at death, maternal age, and maternal race and Hispanic origin.

Methods—Descriptive tabulations of infant deaths by maternal and infant characteristics are presented using the 2017–2018 linked period birth/infant death files; the linked period birth/infant death file is based on birth and death certificates registered in all states and the District of Columbia. The 2017

[1]Significant increasing trend from normal weight to obese (*p* < 0.05).
[2]Significantly higher than normal weight and overweight and significantly lower than obese (*p* < 0.05).
[3]Significantly higher than normal weight and overweight (*p* < 0.05).
[4]Significantly higher than normal weight and significantly lower than obese (*p* < 0.05).
NOTE: Figures may not add to totals because of rounding.
SOURCE: National Center for Health Statistics, National Vital Statistics System, Linked birth/infant death file.

Figure 1. Infant mortality rates, by maternal prepregnancy body mass index and infant age at death: United States, 2017–2018

linked birth/infant death file is the first year that national data on maternal prepregnancy body mass index were available.

Results—Total infant, neonatal, and postneonatal mortality rates were lowest for infants of women who were normal weight prepregnancy, and then rose with increasing prepregnancy body mass index. Total, neonatal, and postneonatal rates were higher for infants of women who were underweight prepregnancy compared with infants of women who were normal or overweight before pregnancy. Mortality rates for infants of underweight women were generally, but not exclusively, lower than those of infants born to women with obesity. Infants born to women of normal weight generally had lower mortality rates than infants born to women who had obesity prepregnancy for all maternal age and race and Hispanic-origin groups.

Keywords: obesity • race and Hispanic origin • infant health • National Vital Statistics System

Introduction

In 2018, slightly more than one-half of women who gave birth in the United States were overweight or had obesity before becoming pregnant (1). An earlier report based on birth certificate data for a 37-state reporting area found that mothers who were older, had less education, were non-Hispanic black or non-Hispanic American Indian or Alaska Native (AIAN), or had Medicaid as the principal source of payment for the delivery were more likely to have obesity before pregnancy (2). Obesity during pregnancy is associated with adverse pregnancy and infant outcomes such as gestational diabetes, preeclampsia, eclampsia, preterm delivery, and greater risk of perinatal, neonatal, and postneonatal mortality (3–8). Starting with the 2017 data year, national data are available for maternal prepregnancy body mass index (BMI) from the period linked birth/infant death file (9). This report examines infant mortality by maternal prepregnancy BMI, and by infant age at death, maternal age, and race and Hispanic origin for combined years 2017 and 2018.

Methods

This report uses data from the 2017–2018 linked birth/infant death period files. The period linked birth/infant death data set includes all infant deaths reported from death certificates and all live births reported from birth certificates (9). Data for this report are based on 99.6% of the 22,341 infant deaths among U.S. residents in 2017 and 99.3% of the 21,498 infant deaths in 2018 (9,10). Records were weighted to compensate for the 0.4% (2017) and 0.7% (2018) of infant death records that could not be linked to their corresponding birth certificates. All data are based on the 2003 U.S. Standard Certificate of Live Birth (11,12), which was nationally implemented in 2016 for births, making 2017 the first year the linked birth/infant death period file included data based exclusively on the 2003 standard. Data from 2017 and 2018 were combined in this report for more reliable rates for subgroups with a small number of yearly events, such as infant deaths to non-Hispanic AIAN women. The number of events was too small to calculate reliable rates (fewer than 20 events in the

numerator) for infants of underweight women aged 40 and over and for infants of underweight non-Hispanic AIAN women.

The infant mortality rate is the number of infant (aged under 1 year) deaths per 1,000 live births in a specified group. Neonatal mortality rates are defined as deaths to infants less than 28 days of age per 1,000 live births. Postneonatal mortality rates are defined as deaths to infants 28 to 364 days of age per 1,000 live births.

Maternal prepregnancy weight and height are recommended to be self-reported by the mother at the time of delivery on the maternal worksheet that is used to collect certain information for the birth certificate (13). Prepregnancy weight is defined as the mother's weight before pregnancy.

Prepregnancy BMI is calculated by taking the mother's weight before pregnancy divided by the mother's height (inches) squared, multiplied by 703. The National Center for Health Statistics (NCHS) provides calculated prepregnancy BMI categories consistent with those from the National Heart, Lung, and Blood Institute in the public-release linked birth/infant death files (14). The BMI categories are: underweight (BMI under 18.5), normal weight (BMI of 18.5 to less than 25.0), overweight (BMI of 25.0 to less than 30.0), and obesity (BMI of 30.0 or more). Of the 43,838 weighted 2017–2018 infant death records, 3,106 (7.1%) were missing data for prepregnancy BMI; of the 7,647,212 birth records for 2017–2018, 182,963 (2.4%) were missing data for prepregnancy BMI. Throughout the rest of this report, maternal prepregnancy BMI is referred to as maternal BMI or BMI.

Race and Hispanic origin are reported separately on the birth certificate. This report includes data for births and infant deaths to Hispanic mothers and for the following non-Hispanic, single-race groups: white, black, AIAN, and Asian. Data for infants of non-Hispanic Native Hawaiian or Other Pacific Islander women were not included due to small numbers of infant deaths. For further details on the race and Hispanic origin of the mother, see the "User Guide to the 2016 Natality Public Use File" (15).

Differences in BMI among groups were tested for statistical significance (9). Differences are statistically significant at the 0.05 level using the *z* test statistic unless otherwise stated. References to decreasing or increasing trends are statistically significant at the 0.05 level and were assessed using the Cochran–Armitage test for trends, a modified chi-squared test.

Results

Distribution of births and infant deaths by maternal BMI (Table 1)

- In 2017–2018, 3.3% of births were to women who were underweight and 42.7% were to normal weight women; among infants who died, 3.5% were born to women who were underweight and 35.8% were born to women of normal weight.
- In 2017–2018, 54.0% of all births were to women who were overweight (26.4%) or had obesity (27.6%); approximately 61% of infants who died in 2017–2018 were born to women who were overweight (25.0%) or had obesity (35.7%).

Infant, neonatal, and postneonatal mortality rates by maternal BMI (Table 2, Figure 1)

- Infant mortality rates by maternal BMI followed a J-shaped curve, with the lowest rate (4.57 per 1,000 births) for infants born to women of normal weight. Rates then rose for births to overweight women (5.16) and women who had obesity (7.07); the rate for infants of women with obesity was 55% higher than that for infants of normal weight women. The infant mortality rate for underweight women (5.84) was higher than that for both normal and overweight women, but 17% lower than that for women with obesity.
- Neonatal mortality rates also followed a J-shaped curve, with the lowest rate for infants of normal weight women. Neonatal mortality rates increased with rising BMI from the normal to obesity weight categories (2.91 for normal, 3.41 for overweight, and 4.76 for obese). The mortality rate for infants born to women who had obesity was 64% higher than the rate for normal weight women. The neonatal mortality rate for infants of underweight women (3.64) was higher than that for normal weight women, but 24% lower than that for women who had obesity.
- Postneonatal mortality rates followed a U-shaped curve, with the lowest rate for infants of normal weight women (1.66) and increasing thereafter to the obesity category (2.30). The rate for infants born to women who had obesity was 39% higher than that for normal weight women. The postneonatal mortality rate for infants of underweight women (2.21) was higher than that for both normal and overweight women (1.75) and similar to that for infants of women who had obesity.

Infant mortality rates by maternal BMI and age (Table 2, Figure 2)

- Mortality rates for infants of women of all age groups followed either a J- or a U-shaped curve, with the lowest rates generally for infants of normal weight women and then increasing with rising maternal BMI.
- Mortality rates for infants of women under age 30 with obesity were 27%–52% higher than rates for infants of normal weight women under age 30; mortality rates for infants of women aged 30 and over with obesity were 64%–92% higher than rates for infants of normal weight women aged 30 and over.
- Mortality rates for infants of females under age 20 were lowest for infants of normal weight females (7.82), increasing to 7.97 among overweight females and to 10.24 among females with obesity. Among infants of underweight females under age 20, the mortality rate (8.46) was lower than that of infants born to females with obesity and higher than that of infants of normal weight females, but the difference between infants of normal weight and infants of underweight females was not statistically significant.
- Mortality rates for infants of women aged 20–24 were lowest for infants of normal weight women (6.09), increasing to 6.22 among infants of overweight women and to 7.72 among women with obesity. Among infants of underweight women aged 20–24, the mortality rate (7.06) was higher than that of infants born to normal weight and overweight women.
- Mortality rates for infants of women aged 25–29 were lowest among infants of normal weight women (4.46), increasing to 4.87 for infants of overweight women and to 6.80 for infants of women with obesity. Among infants of underweight women aged 25–29, the mortality rate (5.64) was higher than the rate for infants born to normal weight or overweight women and lower than the rate for infants born to women with obesity.
- Mortality rates for infants of women aged 30–34 were lowest for infants of normal weight women (3.44), increasing to 4.35 for infants of overweight women and to 6.32 for infants of women with obesity. Among infants of underweight women aged 30–34, the mortality rate (4.24) was higher than the rate for infants born to normal weight women and lower than that for infants born to women with obesity.
- Mortality rates for infants of women aged 35–39 were lowest for infants of normal weight women (3.66), increasing to 4.79 for infants of overweight women and to 7.01 for infants of women with obesity. Among infants of underweight women aged 35–39, the mortality rate (3.81) was lower than that of infants born to women with obesity but did not differ significantly from rates for infants born to normal or overweight women.
- Mortality rates for infants of women aged 40 and over were lowest for infants of normal weight women (5.26), increasing to 6.71 for infants of overweight women and to 8.61 for infants of women with obesity. The number of events was too small to calculate reliable rates (fewer than 20 events in the numerator) for infants of women aged 40 and over who were underweight.

Infant mortality rates by maternal BMI and race and Hispanic origin (Table 2, Figure 3)

- Infant mortality rates for the race and Hispanic-origin groups followed somewhat different patterns. For non-Hispanic white, non-Hispanic black, non-Hispanic Asian, and Hispanic women, mortality rates increased with rising maternal BMI from infants of normal weight women through infants of women with obesity. The mortality rate for infants of women who had obesity ranged from 31% through 109% higher than that for infants of normal weight women among the race and Hispanic-origin groups, with the exception of mortality rates for infants of non-Hispanic AIAN women, among whom rates were higher for infants of normal weight women compared with infants of women with obesity.
- Mortality rates among infants of non-Hispanic white women followed a U-shaped curve, with the lowest rate for infants of normal weight women (3.88), increasing to 4.22 among overweight women and to 5.66 among women with obesity. Among non-Hispanic white women, the mortality rate for infants born to underweight women (5.70) was not
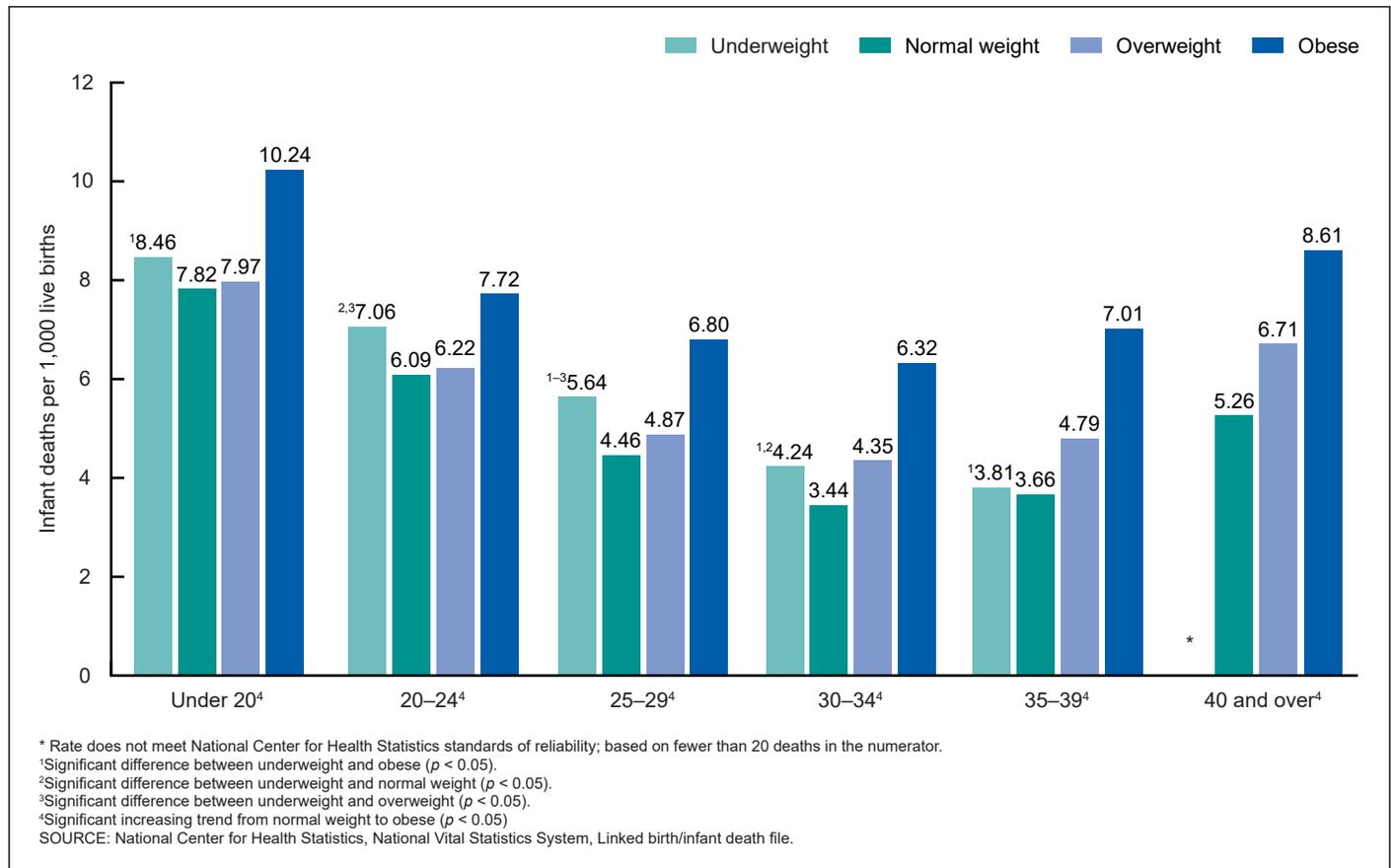
Figure 2. Infant mortality rates, by maternal prepregnancy body mass index and age: United States, 2017–2018

significantly higher than the rate for infants born to women with obesity.

- Infant mortality rates for infants of non-Hispanic black women followed a J-shaped curve; rates increased from infants of normal weight women (9.11) through infants of women with obesity (12.02); the rates for infants of underweight women (9.97) were higher than those of infants born to normal weight women, but the difference was not statistically significant.

- Mortality rates for infants of non-Hispanic AIAN women were not statistically different for the normal through obesity categories; rates were 8.86 for infants of normal weight women, 7.37 for infants of overweight women, and 8.23 for infants of non-Hispanic AIAN women with obesity. The number of events was too small to calculate reliable rates (fewer than 20 events in the numerator) for infants of underweight non-Hispanic AIAN women.

- Mortality rates for infants of non-Hispanic Asian women increased as BMI increased, rising from 2.54 for infants of underweight women to 3.03 for normal weight, 4.19 for overweight, and 6.32 for infants of women with obesity.

- Among infants of Hispanic women, mortality rates increased with rising BMI from the normal weight (4.33) through obesity (5.68) categories, and rates for underweight women (5.42) were not significantly different from those of women with obesity.

Discussion

This report shows variation in infant mortality rates by maternal BMI, overall and by infant age at death, maternal age, and maternal race and Hispanic origin. Generally, infant mortality increased as maternal BMI increased from the normal through obese weight categories. Infant mortality for infants of underweight women was generally, though not exclusively, higher than that for infants of normal weight women but lower than that of women with obesity. One exception to this pattern was for infants of non-Hispanic Asian women, among whom the lowest risk of death was for infants of underweight, not normal weight, women; rates for this group then rose with increasing BMI.

The findings of this analysis showing that mortality risk is consistently higher for infants of women with obesity compared with normal weight women for each infant age at death group, and across maternal age and maternal race and Hispanic-origin groups, are consistent with those of other studies based on birth certificate and other data sources showing poorer birth outcomes for infants of women with obesity (3,4,6–8).

Limitations

Previous research has shown that height is often overreported and weight is often underreported when individuals self-report these measures (2,16,17). Inaccurate reporting could
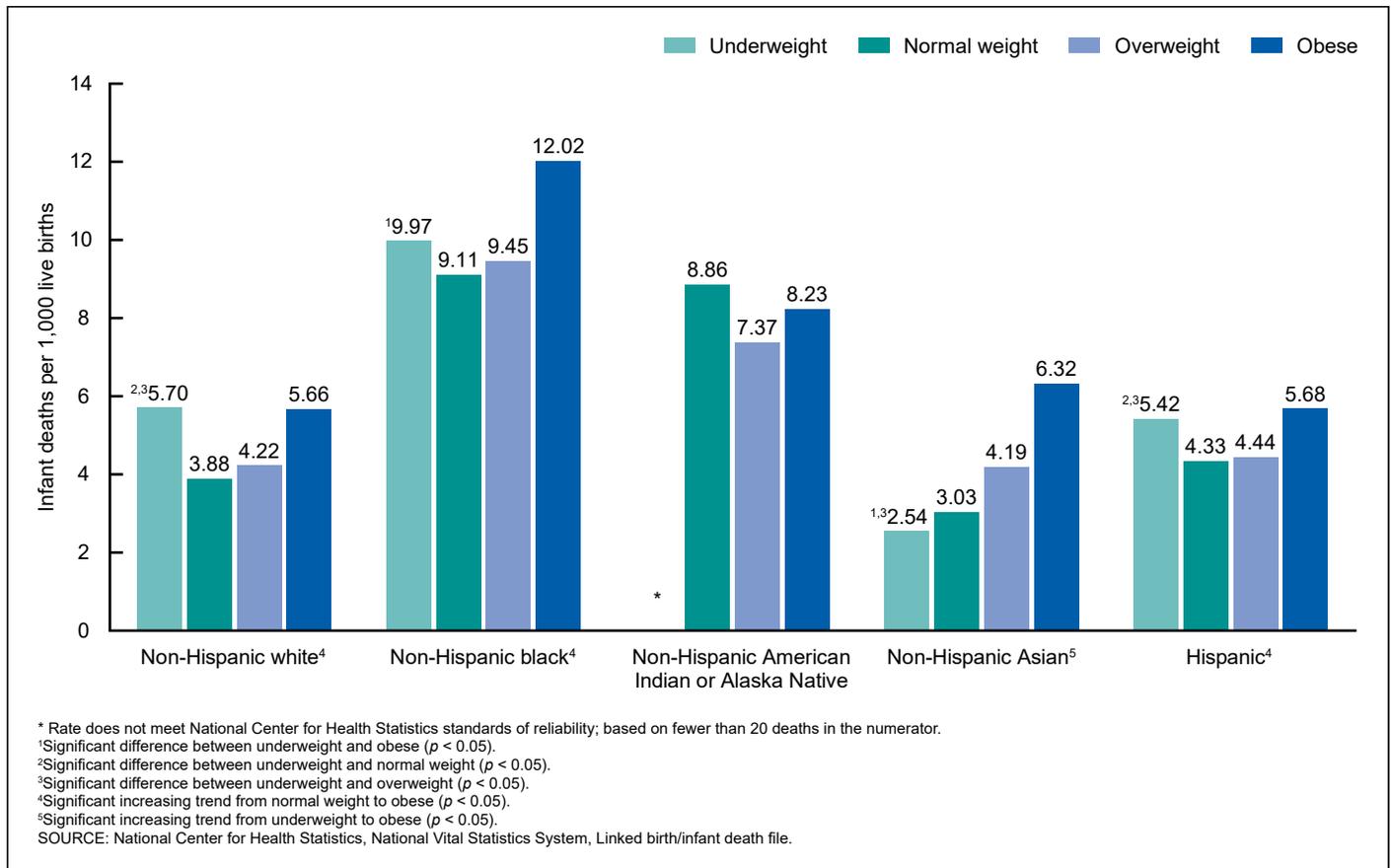
Figure 3. Infant mortality rates, by maternal prepregnancy body mass index and race and Hispanic origin: United States, 2018

lead to misclassification bias when assessing the effect of obesity or weight status on health outcomes (2). Further, the quality of self-reported BMI, based on levels of missing data, varies by maternal race and ethnicity. In the 2017–2018 period linked files, height or weight data used to calculate BMI was missing for 1.9% of births and 5.5% of infant deaths to non-Hispanic white mothers, 3.4% of births and 8.2% of infant deaths to non-Hispanic black mothers, 2.6% of births and 7.2% of infant deaths to non-Hispanic AIAN mothers, 2.3% of births and 6.0% of infant deaths to non-Hispanic Asian mothers, and 2.7% of births and 6.1% of infant deaths to Hispanic mothers. These differences may result in different levels of misclassification bias among mothers of different racial and ethnic origins (18).

An additional limitation of this report is that it did not account for the effect of gestational weight gain (GWG) on birthweight and other infant outcomes. Excessive GWG is associated with increased risk of the infant being large for gestational age; however, excessive GWG can be a protective factor for the infant compared with inadequate GWG where there is a greater risk of infant death, preterm birth, and being small for gestational age, specifically for infants of women who were underweight before pregnancy, with decreasing positive effects as BMI before pregnancy increases (19–21). The relationship between BMI and increased birthweight varies among women with different GWG (22,23). GWG could explain some of the differences in birthweight and other infant outcomes related to

infant mortality among women with different BMIs (23). Finally, pregnant women with obesity are more likely to have other conditions associated with adverse pregnancy outcomes, such as prepregnancy diabetes, gestational diabetes, prepregnancy hypertension, gestational hypertension, and preeclampsia, and are at greater risk of having infants with birth defects, which are not reported here (24–26). There may also be other residual confounding or unmeasured factors contributing to differences in infant mortality by maternal BMI.

Summary

Infants born to women who were normal weight before pregnancy generally had lower mortality rates compared with infants born to women who were underweight, overweight, and with obesity.

Nonoptimal BMI before pregnancy has implications for infant and maternal health, given the potential for adverse health outcomes for both women and infants. A primary advantage of the linked period birth/infant death file is that it links data from infant death records to their respective birth certificates, allowing for analysis of infant deaths by maternal health and demographic characteristics. Despite potential concerns with reporting misclassification, the findings in this report may help to inform research and prevention efforts on infant mortality related to maternal prepregnancy factors.

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List of Detailed Tables

Table 1. Percent distribution of births and infant deaths, by maternal body mass index: United States, 2017–2018

Number and percent	Total	Underweight (BMI under 18.5)	Normal weight (BMI 18.5–24.9)	Overweight (BMI 25.0–29.9)	Obese (BMI 30.0 or more)	Not stated[1]
Live births						
Number	7,647,212	244,734	3,189,241	1,972,220	2,058,054	182,963
Percent[2]	100.0	3.3	42.7	26.4	27.6	…
Infant deaths						
Number	43,838	1,430	14,581	10,181	14,542	3,106
Percent[2]	100.0	3.5	35.8	25.0	35.7	…

… Category not applicable.

[1] No response reported for maternal height or prepregnancy weight items on the birth certificate.

[2] Excludes not stated BMI.

NOTE: BMI is body mass index.

SOURCE: National Center for Health Statistics, National Vital Statistics System, Linked birth/infant death file.

Table 2. Infant mortality rates, live births, and infant deaths, by maternal body mass index, infant age at death, maternal age, and maternal race and Hispanic-origin group: United States, 2017–2018

Characteristic	Total	Underweight (BMI under 18.5)	Normal weight (BMI 18.5–24.9)	Overweight (BMI 25.0–29.9)	Obese (BMI 29.9 or more)	Not stated[1]
Infant deaths per 1,000 live births in specified group						
Overall	5.73	5.84	4.57	5.16	7.07	…
Age at death:						
Neonatal	3.81	3.64	2.91	3.41	4.76	…
Postneonatal.	1.92	2.21	1.66	1.75	2.30	…
Maternal age:						
Under 20	8.84	8.46	7.82	7.97	10.24	…
20–24	6.93	7.06	6.09	6.22	7.72	…
25–29	5.56	5.64	4.46	4.87	6.80	…
30–34	4.69	4.24	3.44	4.35	6.32	…
35–39	5.19	3.81	3.66	4.79	7.01	…
40 and over	6.98	*	5.26	6.71	8.61	…
Race and Hispanic origin[2]:						
Non-Hispanic white	4.65	5.70	3.88	4.22	5.66	…
Non-Hispanic black.	10.86	9.97	9.11	9.45	12.02	…
Non-Hispanic American Indian or Alaska Native	8.69	*	8.86	7.37	8.23	…
Non-Hispanic Asian	3.71	2.54	3.03	4.19	6.32	…
Hispanic	4.98	5.42	4.33	4.44	5.68	…
Live births						
Overall	7,647,212	244,734	3,189,241	1,972,220	2,058,054	182,963
Age at death:						
Neonatal	7,647,212	244,734	3,189,241	1,972,220	2,058,054	182,963
Postneonatal.	7,647,212	244,734	3,189,241	1,972,220	2,058,054	182,963
Maternal age:						
Under 20	377,901	26,006	183,540	86,614	71,489	10,252
20–24	1,490,955	69,653	608,458	368,257	409,113	35,474
25–29	2,223,068	68,793	893,709	574,119	635,753	50,694
30–34	2,182,614	53,042	942,084	570,342	566,563	50,583
35–39	1,121,582	22,848	464,875	301,527	303,588	28,744
40 and over	251,092	4,392	96,575	71,361	71,548	7,216
Race and Hispanic origin[2]:						
Non-Hispanic white	3,948,874	124,840	1,795,848	971,645	982,803	73,738
Non-Hispanic black.	1,112,744	33,102	350,531	288,112	402,880	38,119
Non-Hispanic American Indian or Alaska Native	59,049	1,236	17,717	15,732	22,834	1,530
Non-Hispanic Asian	490,048	34,642	290,358	109,018	44,954	11,076
Hispanic	1,784,974	42,651	635,680	525,811	533,258	47,574
Infant deaths						
Overall	43,838	1,430	14,581	10,181	14,542	3,106
Age at death:						
Neonatal	29,172	890	9,283	6,731	9,799	2,470
Postneonatal.	14,666	540	5,298	3,450	4,742	636
Maternal age:						
Under 20	3,340	220	1,435	690	732	263
20–24	10,330	492	3,707	2,289	3,159	684
25–29	12,359	388	3,983	2,797	4,323	869
30–34	10,236	225	3,245	2,483	3,582	701
35–39	5,821	87	1,703	1,443	2,129	460
40 and over	1,752	18	508	479	616	130

See footnotes at end of table.

Table 2. Infant mortality rates, live births, and infant deaths, by maternal body mass index, infant age at death, maternal age, and maternal race and Hispanic-origin group: United States, 2017–2018—Con.

Characteristic	Total	Underweight (BMI under 18.5)	Normal weight (BMI 18.5–24.9)	Overweight (BMI 25.0–29.9)	Obese (BMI 29.9 or more)	Not stated[1]
Infant deaths—Con.						
Race and Hispanic origin[2]:						
Non-Hispanic white	18,365	712	6,971	4,105	5,561	1,016
Non-Hispanic black.	12,085	330	3,193	2,723	4,843	995
Non-Hispanic American Indian or Alaska Native	513	15	157	116	188	37
Non-Hispanic Asian	1,817	88	880	457	284	109
Hispanic	8,887	231	2,750	2,337	3,029	540

… Category not applicable.

* Rate does not meet National Center for Health Statistics standards of reliability; based on fewer than 20 deaths in the numerator.

[1]No response reported for maternal height or prepregnancy weight items on the birth certificate.

[2]Race and Hispanic origin are reported separately on birth certificates. Race categories are consistent with the 1997 Office of Management and Budget standards. Persons of Hispanic origin may be of any race.

NOTE: BMI is body mass index.

SOURCE: National Center for Health Statistics, National Vital Statistics System, Linked birth/infant death file.

Technical Notes

Availability of the linked file

Linked file data are available for download at: Vital Stats online. Linked period file data may also be accessed via the Centers for Disease Control and Prevention's (CDC) Wide-ranging Online Data for Epidemiologic Research (WONDER). Beginning with 2005, the public-use file no longer includes geographic detail; these files are available upon special request (see Division of Vital Statistics release policy). Data are also available in issues of Vital and Health Statistics, Series 20; National Vital Statistics Reports; and Data Briefs from the NCHS website.

For more NCHS NVSRs, visit:
https://www.cdc.gov/nchs/products/nvsr.htm.

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Contents

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National Center for Health Statistics

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