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National Hospital Care Survey Demonstration Projects: Examination of Maternal Health Outcomes by Housing Assistance Status

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Abstract

Objective—This report demonstrates the use of linked National Hospital Care Survey (NHCS) and U.S. Department of Housing and Urban Development (HUD) administrative data to examine demographic characteristics and maternal health outcomes among both patients who received and did not receive housing assistance.

Methods—Administrative claims data and electronic health records data from the 2016 NHCS were linked to 2015–2017 HUD administrative data using patient identifiers. HUD administrative data for Housing Choice Voucher, Public Housing, and Multifamily housing program participation were used to identify patients who received housing assistance before, during, or after their delivery hospitalization. Exploratory analyses were conducted for patients who had a delivery hospitalization in 2016 and were eligible for linkage to HUD administrative data. Demographic characteristics and maternal health outcomes were compared by housing assistance status. The linked NHCS–HUD data are unweighted and not nationally representative.

Results—In the 2016 NHCS, 146,672 patients had a delivery hospitalization and were eligible for linkage to 2015–2017 HUD administrative data (95.6% had a live birth, 1.0% had a stillbirth, and 3.4% were unspecified). Among this study population, 9,559 patients (6.5%) received housing assistance from 2015 to 2017. Among those who received housing assistance, 66.5% visited large metropolitan hospitals, 71.8% were insured by Medicaid, and 3.0% experienced severe maternal morbidity. Among patients who did not receive housing assistance, 74.0% visited large metropolitan hospitals, 35.6% were insured by Medicaid, and 1.9% experienced severe maternal morbidity. Nearly two-thirds of patients who received housing assistance from 2015 to 2017 were receiving housing assistance at the time of their delivery hospitalization (63.6%).

Conclusion—Although these findings are not nationally representative, this report illustrates how linked NHCS–HUD data may provide insight into maternal health outcomes of patients who received housing assistance compared with those who did not.

Keywords: U.S. Department of Housing and Urban Development (HUD) • severe maternal morbidity • urban • rural • health insurance coverage • National Hospital Care Survey

Introduction

Where people live, the conditions where they live, affordability, and safety are all key housing factors known to affect the health of children and families (1–3). Yet few studies have explicitly explored housing as a social determinant of maternal health outcomes (4). The studies that have explored this connection use housing data limited to state or region, rely on self-reported surveys, and place emphasis on infant health, while only a few of them use objective clinical outcomes such as those found in a hospital record (5–7). A few resources offer information on both housing and clinical outcomes—among them, a data set produced by linking data from the National Hospital Care Survey (NHCS) to administrative data from the U.S. Department of Housing and Urban Development (HUD).

Data from HUD and NHCS were linked in 2021 using the National Center for Health Statistics linkage program with funding from the Office of the Secretary Patient-Centered Outcomes Research Trust Fund (8). Both HUD and NHCS collect personally identifiable information (PII), which allowed linking 2016 NHCS data to 2015–2017 HUD administrative data. This data linkage

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provided a unique resource for extensive research on a variety of patient health outcomes, including understanding the role of housing assistance as a social determinant of health. NHCS data alone have been used previously as a source for studying maternal health outcomes (9). The linkage of NHCS data to HUD administrative data is an opportunity to study demographic characteristics and maternal health outcomes by housing assistance status.

Objectives

Using the linked 2016 NHCS and 2015–2017 HUD administrative data, exploratory analyses were conducted for patients who had a delivery hospitalization and were eligible for linkage to HUD administrative data. Although NHCS data are unweighted and not nationally representative, this report illustrates the use of the linked data to:

1. Identify patients by housing assistance status (patients who received housing assistance before, during, or after their delivery hospitalization, and patients who did not receive housing assistance).
2. Examine demographic characteristics (as in hospital location, health insurance coverage, and maternal age) and maternal health outcomes (as in gestational age, cesarean delivery, and average length of stay) by housing assistance status.

Methods

Data sources

2016 NHCS

NHCS provides data on health care utilization across hospital settings through data collection of inpatient discharges and emergency department visits from sampled eligible hospitals. Hospitals eligible for sampling are noninstitutional, nonfederal hospitals in the 50 states and District of Columbia that have six or more staffed inpatient beds. The clinical data include patients' PII and detailed information about the patients' characteristics, conditions, and treatment. NHCS collects PII such as patient name, date of birth, and Social Security number to track patients across hospital settings and during an episode of care by linking records within the same hospital.

NHCS collects a calendar year of electronic health records or Uniform Billing (UB-04) administrative claims data from a sample of hospitals. Due to the relatively low participation rate in 2016 (27.2%), the data are unweighted and not nationally representative. The electronic health records and UB-04 data include information on patient demographics, diagnoses, services received, and discharge status. More details about NHCS methodology are published elsewhere (10).

HUD

HUD is the primary federal agency responsible for overseeing domestic housing programs and policies. HUD has three key programs that aim to assist very low-income families, the elderly, and people who are disabled to afford safe housing in the private market: 1) Housing Choice Voucher program, in which eligible participants receive a rental subsidy or the ability to rent homes at a cost below market value; 2) Public Housing program, which provides capital subsidies and operating subsidies to local public housing agencies and manages public housing for eligible low-income residents; and 3) Multifamily housing programs, which provide subsidies directly to private property owners who provide a certain percentage of their housing units at affordable rates to those who qualify (8).

Eligibility for these programs is based on income, immigration status, and household size. To determine eligibility, HUD collects a wide range of administrative data that includes an applicant's public housing status. Once participants are enrolled in a HUD program, these data are continually collected for eligibility assessments and disbursement. Consequently, HUD has a robust repository of household- and personal-level administrative records of participants from all states, the District of Columbia, and some U.S. territories. HUD administrative data are an excellent resource for population research. These data become greatly more resourceful when linked with supplemental national data from NHCS.

Linkage of 2016 NHCS to 2015–2017 HUD administrative data

Electronic health records and UB-04 administrative claims data from the 2016 NHCS were linked to 2015–2017 HUD administrative data using patient identifiers. The 2015–2017 HUD administrative data contain enrollment information in HUD's three major programs: Housing Choice Voucher, Public Housing, and Multifamily (8). Linkage-eligible NHCS patient records were linked to the HUD enrollment database using both deterministic and probabilistic linkage approaches, using Social Security number; first name, last name, and middle initial; month, day, and year of birth; five-digit zip code; state of residence; and sex. NHCS patient records were screened to determine if they had at least two of three identifiers: valid Social Security number, valid date of birth, or valid name. Records that did not meet these minimum data requirements were considered ineligible for linkage. Linked data are reported from 77 sampled hospitals that submitted inpatient data, representing an unweighted total of about 1.4 million non-newborn hospitalizations and about 4.7 million emergency department visits. See the NHCS–HUD linkage methodology report for additional details (8).

Definitions

Delivery hospitalization

Hospitalizations—Encounters in the hospital inpatient department.

Delivery hospitalizations—Hospitalizations for the delivery of an infant. A patient could have multiple delivery hospitalizations in 2016; as a result, only the patient's last delivery hospitalization was included in the analysis.

- For UB-04 administrative claims data, delivery hospitalizations were defined as inpatient encounters with at least one of the *International*

Classification of Diseases, 10th Revision, Clinical Modification (ICD–10–CM) diagnosis codes detailed in Table I.

- For electronic health records data, delivery hospitalizations were identified using *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD–9–CM), ICD–10–CM, or 679 Systematized Nomenclature of Medicine—Clinical Terms diagnosis codes that corresponded with the ICD–9–CM and ICD–10–CM diagnosis codes described in Table I.

According to the ICD–9–CM and ICD–10–CM official guidelines, diagnosis codes V27 and Z37 "should be included on every maternal record when a delivery has occurred" (11,12). The remaining codes provide further description of the delivery (as in term or preterm, uncomplicated or had complications, or cesarean). Although the transition from ICD–9–CM to ICD–10–CM occurred in late 2015, 17.6% of diagnosis codes found in electronic health records data were ICD–9–CM codes.

Housing assistance status

Received housing assistance—Patients who had a delivery hospitalization in 2016 and who participated in HUD's Housing Choice Voucher, Public Housing, or Multifamily housing programs from 2015 to 2017. In the HUD Match File of variables (8), these patients had a HUD_MATCH_STATUS value of 1 (9,559 patients, or 4.2%).

Patients who received housing assistance were further split into three groups (Figures I and II) to examine demographic characteristics and maternal health outcomes by timing of housing assistance:

- *Patients who received housing assistance before their delivery hospitalization*—For example, patient I has a delivery hospitalization in March 2016 and was enrolled in a HUD program from February to December 2015 (Figure II). Patients in this group disenrolled in a HUD program at some point before their delivery, perhaps due to no longer being eligible for housing assistance (as in exceeding income limits) or for other reasons.
- *Patients who received housing assistance during their delivery hospitalization*—For example, patient II has a delivery hospitalization in March 2016 and was enrolled in a HUD program from April 2015 to December 2016 (Figure II). Patients in this group were studied to provide insight into the characteristics and outcomes of patients who were actively enrolled in a HUD program at the time of their delivery.
- *Patients who received housing assistance after their delivery hospitalization*—For example, patient III has a delivery hospitalization in March 2016 and was enrolled in a HUD program from September to December 2017 (Figure II). Patients in this group were studied to provide insight into the characteristics and outcomes of patients who sought housing assistance during their postpartum period. Patients who may have enrolled in a HUD program before and after (but not during) their delivery hospitalization were classified as having received housing assistance after their delivery hospitalization, to capture their most recent interaction with a HUD program. For example, patient IV, who has a delivery hospitalization in March 2016 and was enrolled in a HUD program July 2015–January 2016 and October 2016–December 2017, is in this category (Figure II).

Whether the patient was enrolled in a HUD program before, during, or after their delivery hospitalization was determined by comparing the month and year of when the delivery hospitalization occurred with the monthly indicator variables included in the Any HUD Program Participation File. For example, as noted in Figure II, patient II has a delivery hospitalization in March 2016 and the housing assistance enrollment period was identified with the monthly indicator variables of ANY_PGRM_XXX2015 through ANY_PGRM_XXX2017 equal to 1 in the Any HUD Program Participation File (with XXX representing the three-letter month of participation, JAN–DEC). In the Any HUD Program Participation File, patient II had the monthly indicator variables of ANY_PGRM_APR2015 through ANY_PGRM_DEC2016 equal to 1, meaning that this patient was enrolled in a HUD program from April 2015 to December 2016. Since the delivery hospitalization date of March 2016 occurs during the housing assistance enrollment period, this patient was identified as having received housing assistance during their delivery hospitalization.

Did not receive housing assistance—Patients who had a delivery hospitalization in 2016, were eligible for linkage to HUD administrative data, but did not participate in any of HUD's Housing Choice Voucher, Public Housing, or Multifamily housing programs from 2015 to 2017. In the HUD Match File of variables (8), these patients had a HUD_MATCH_STATUS value of 0 (137,113 patients, or 60.2%).

Ineligible for data linkage—Patients with a HUD_MATCH_STATUS value of 9 were not eligible for data linkage and were excluded from this analysis (80,970 patients, or 35.6%).

For additional details on how the five groups defined above were determined—patients who received housing assistance before, during, or after their delivery hospitalization; who did not receive housing assistance; and who were ineligible for data linkage—see the "Identification of Ever and Concurrent HUD-Assisted Patients" section in the NHCS–HUD linkage methodology report (8).

Study population

This report examines delivery hospitalizations in women of reproductive age (ages 12–55) that occurred between January 1, 2016, and December 31, 2016, using the linked 2016 NHCS and 2015–2017 HUD administrative data. In the 2016 NHCS, 227,642 patients had a delivery hospitalization. For context, about 3.95 million births occurred in the United States in 2016 (13). Of these

227,642 patients, 146,672 or 64.4% were eligible for linkage to the 2015–2017 HUD administrative data. Linkage could not be completed for 35.6% of patients (80,970) due to lack of PII. About 77% of patients who lacked PII visited hospitals from one organization in the NHCS data that submitted UB-04 administrative claims data.

Demographic characteristics and maternal health outcomes

The following demographic characteristics and maternal health outcomes were assessed among the 146,672 linkage-eligible patients who had a delivery hospitalization in 2016.

Demographic characteristics

Hospital location—Based on the 2013 National Center for Health Statistics Urban–Rural Classification Scheme for Counties (14):

- *Large metropolitan*—Hospitals located in metropolitan statistical areas with a population of 1 million people or more.
- *Small–medium metropolitan*—Hospitals located in metropolitan statistical areas with a population less than 1 million people.
- *Rural*—Hospitals located in micropolitan or noncore counties.

Health insurance coverage—The payer that covers some or all of the patient's healthcare expenses at delivery. Patients were grouped into five mutually exclusive groups: 1) uninsured, 2) Medicaid, 3) private insurance, 4) other insurance, and 5) missing or unspecified insurance (6,704 patients or 4.6% were missing health insurance coverage data).

Maternal age—Provided on the medical record or calculated using the patient's date of birth and the starting date of delivery hospitalization. The sample was restricted to female patients from ages 12 to 55, based on ICD–10–CM delivery code rules. Patients were then grouped into four age categories: 12–17, 18–24, 25–34, and 35–55 (15,16).

Maternal health outcomes

Gestational age—The age in weeks of the pregnancy at the time of delivery. Gestational age was identified using the last two digits of the ICD–10–CM diagnosis code Z3A—for example, the code Z3A.33 corresponds to a gestational age of 33 weeks (9). Gestational age was reported as an average and as a categorical outcome of preterm (gestational age of less than 37 weeks) or term (37 weeks or later) birth. A total of 5,877 patients (4.0%) were missing gestational age data.

Severe maternal morbidity (*SMM*)—Describes the serious complications of delivery that result in short- or long-term consequences to a patient's health (17). The presence of SMM is a critical indicator of poor maternal health outcomes. A total of 21 indicators of SMM classified by the Centers for Disease Control and Prevention were used to identify delivery hospitalizations of interest (18). Indicators of SMM are composed of conditions and procedures; patients were classified as having SMM if they had one or more indicators during the delivery hospitalization. Indicators of SMM are detailed in Tables II and III.

Cesarean delivery—Identified using one of the following: ICD–10 *Procedure Coding System* (ICD–10–PCS) codes beginning with 10D; a Current Procedural Terminology code; or ICD–10–CM codes O75.82 or O82. While the medical codes (diagnostic and procedure) identify cesarean deliveries, they do not indicate whether the cesarean delivery was elective (desired by the patient) or medically necessary. The Centers for Medicare & Medicaid Services' ICD–10–PCS and ICD–10–CM coding guidelines, as well as evidence-based indications for cesarean delivery, were used to further classify cesarean deliveries (12, 19–21). If a patient had codes indicating a cesarean delivery and codes listed in Table IV (obstetric, fetal, and maternal conditions that require or increase the risk for cesarean delivery), they were classified as having a medically necessary cesarean delivery. Medically necessary cesarean deliveries were either emergent or medically indicated.

Length of stay—Provided on the medical record or calculated using the date of admission and ending date of the delivery hospitalization. Length of stay in the intensive care unit (ICU) is the time from admission of the patient to the ICU to either discharge or transfer from the ICU.

Analysis

No statistical comparisons were conducted, because this report is meant to illustrate the type of analysis that can be performed with NHCS, not to produce official representative estimates of delivery hospitalizations. Descriptive analyses were performed to describe the study population. Percent distributions or averages were calculated for each demographic characteristic or maternal health outcome of interest. PII and hospital encounter start time were used to identify each patient's last delivery hospitalization, which allows for the reporting of estimates at the patient level.

Results

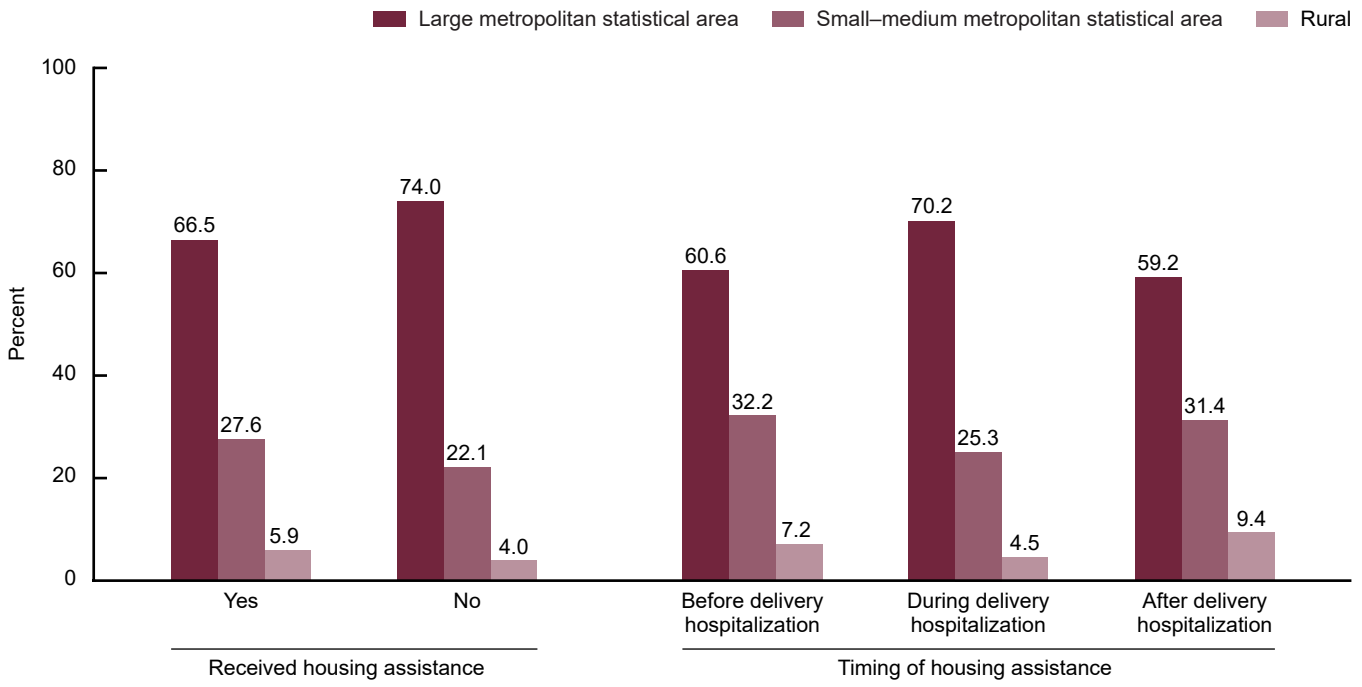
Housing assistance status

In the 2016 NHCS, 227,642 patients had a delivery hospitalization. Among these patients, 146,672 patients (64.4%) were eligible for linkage to HUD administrative data. More than 95% of patients had a live birth, 1.0% had a stillbirth, and 3.4% were unspecified. Table 1 shows the distribution of these patients by housing assistance status. Most patients (93.5%) did not receive housing assistance, while 9,559 patients (6.5%) received housing assistance from 2015 to 2017. Among patients who received housing assistance, 17.7% received housing assistance before delivery, 63.6% at delivery, and 18.7% after delivery (Figure I).

Hospital location

Figure 1 describes the distribution of patients by hospital location and housing assistance status. Regardless of housing assistance status and time of receipt for patients who received housing assistance, most patients delivered at hospitals located in large metropolitan areas.

Figure 1. Percentage of linkage-eligible patients, by hospital location and housing assistance status: Linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data



NOTES: A total of 146,672 linkage-eligible patients had a delivery hospitalization in 2016, of whom 9,559 received housing assistance during 2015–2017—1,692 patients who had housing assistance before, 6,076 during, and 1,791 after their delivery hospitalization. Data are not nationally representative. Hospital location was classified based on "2013 NCHS Urban–Rural Classification Scheme for Counties" (available from: https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf). Rural includes nonmetropolitan statistical areas. Linkage-eligible patients are women ages 12–55 who had at least two patient identifiers and a delivery hospitalization in 2016.
SOURCE: National Center for Health Statistics, linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data.

- Nearly three-quarters of patients who did not receive housing assistance (74.0%) and about two-thirds of patients who received housing assistance (66.5%) delivered at hospitals located in large metropolitan areas.
- The percentage of patients who delivered at a rural hospital was 5.9% among patients who received housing assistance and 4.0% among patients who did not receive housing assistance.
- Seven in 10 patients who received housing assistance at delivery delivered at a hospital located in a large metropolitan area (70.2%), compared with 60.6% of patients who received housing assistance before delivery and 59.2% of patients who received housing assistance after delivery.
- About 1 in 10 patients who received housing assistance after delivery delivered at a rural hospital (9.4%), compared with 7.2% of patients who received housing assistance before delivery and 4.5% of patients who received housing assistance at delivery.

Health insurance coverage

Figure 2 describes the distribution of patients by health insurance coverage and housing assistance status.

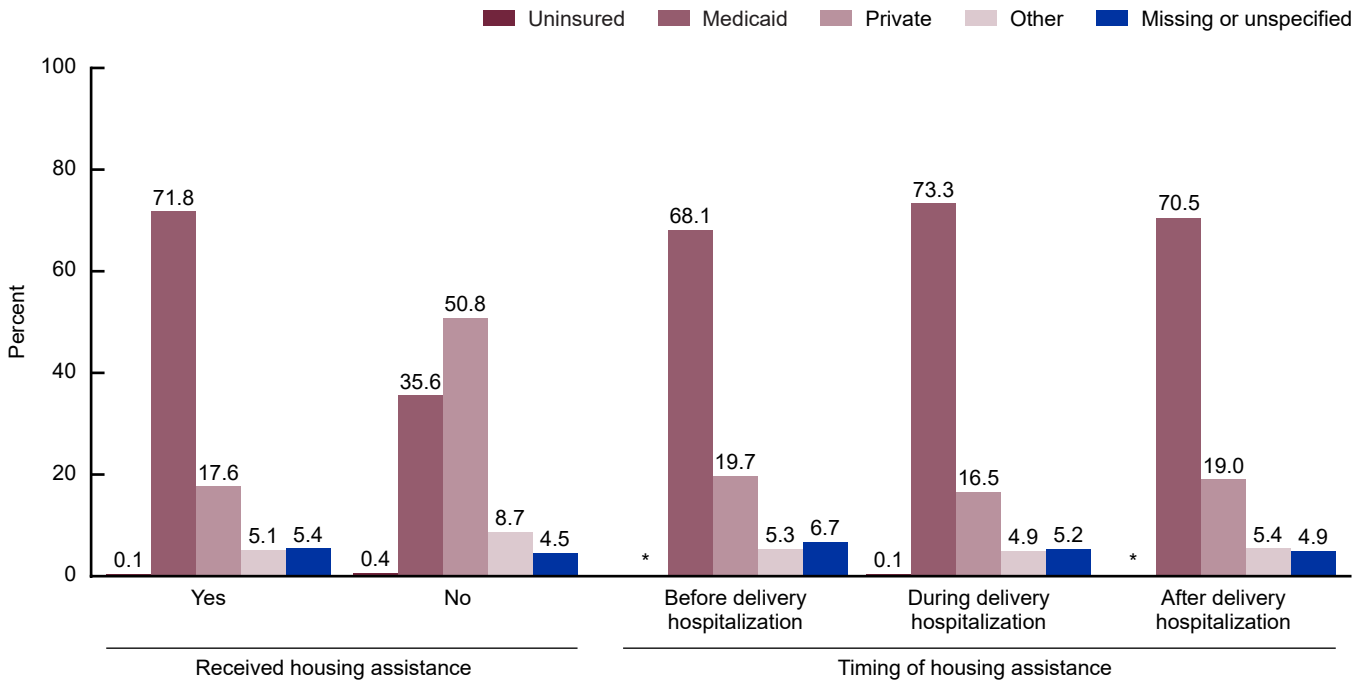
- Most patients who received housing assistance were insured by Medicaid (71.8%), while about one-third of patients who did not receive housing assistance were insured by Medicaid (35.6%).
- Slightly more than one-half of patients who did not receive housing assistance were insured privately (50.8%) compared with 17.6% of patients who received housing assistance.
- Nearly three-quarters of patients who received housing assistance at the time of delivery were insured by Medicaid (73.3%), compared with 68.1% of patients who received housing assistance before delivery and 70.5% of patients who received housing assistance after delivery.
- The percentage of patients with private insurance was 16.5% for those who received housing assistance at the time of delivery, 19.7% for those who received housing assistance before delivery, and 19.0% for those who received housing assistance after delivery.

Maternal age

Figure 3 shows the distribution of patients by maternal age and housing assistance status.

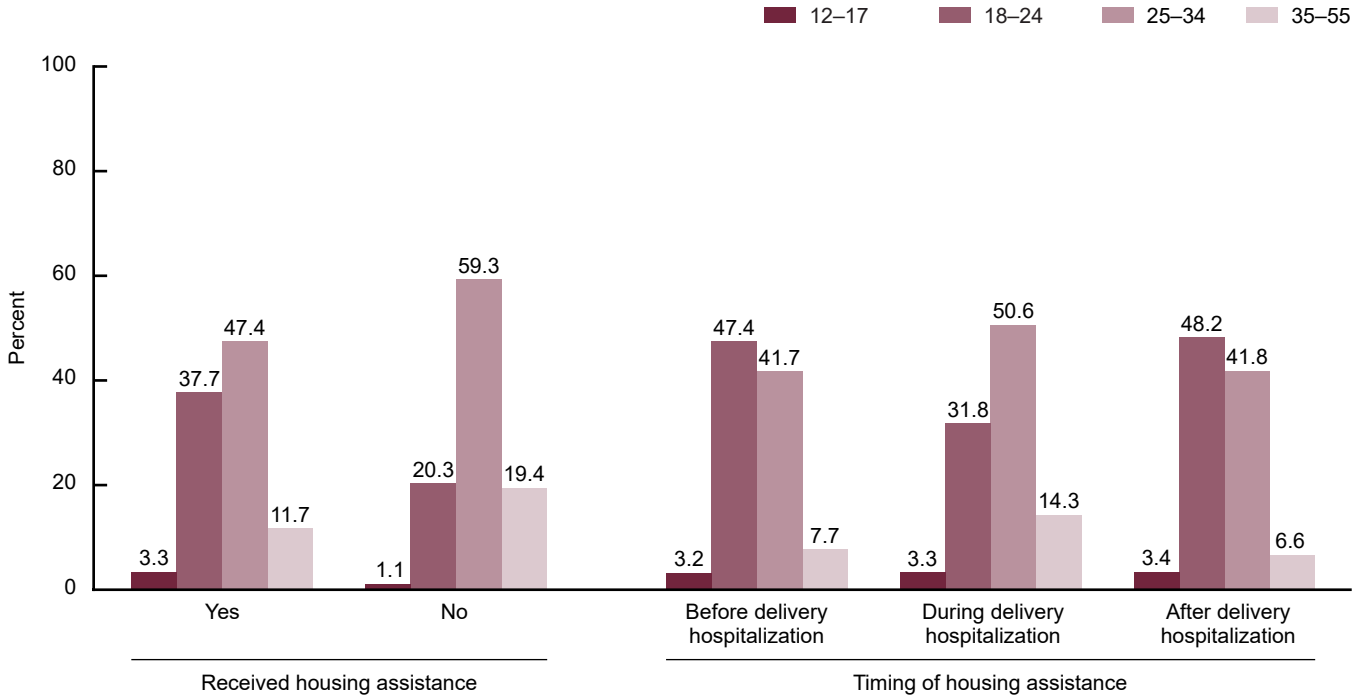
- Most patients with delivery hospitalizations were ages 25–34 regardless of housing assistance status. A total of 59.3% patients ages 25–34 did not receive housing assistance, compared with 47.4% of patients who received housing assistance.
- More than one-third of patients who received housing assistance were ages 18–24 (37.7%) compared with 20.3% of patients who did not receive housing assistance.
- The percentage of patients who were ages 12–17 was 3.3% among those who received housing assistance compared with 1.1% among patients who did not receive housing assistance.

Figure 2. Percentage of linkage-eligible patients, by health insurance coverage and housing assistance status: Linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data



* Estimate does not meet National Center for Health Statistics standards of reliability.
NOTES: A total of 146,672 linkage-eligible patients had a delivery hospitalization in 2016, of whom 9,559 received housing assistance during 2015–2017—1,692 patients who had housing assistance before, 6,076 during, and 1,791 after their delivery hospitalization. Data are not nationally representative. Linkage-eligible patients are women ages 12–55 who had at least two patient identifiers and a delivery hospitalization in 2016.
SOURCE: National Center for Health Statistics, linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data.

Figure 3. Percentage of linkage-eligible patients, by maternal age group and housing assistance status: Linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data



NOTES: A total of 146,672 linkage-eligible patients had a delivery hospitalization in 2016, of whom 9,559 received housing assistance during 2015–2017—1,692 patients who had housing assistance before, 6,076 during, and 1,791 after their delivery hospitalization. Data are not nationally representative. Linkage-eligible patients are women ages 12–55 who had at least two patient identifiers and a delivery hospitalization in 2016.
SOURCE: National Center for Health Statistics, linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data.

- About one-half of patients who received housing assistance at the time of delivery were ages 25–34 (50.6%), compared with 41.7% of patients who received housing assistance before and 41.8% after delivery. The percentage of patients who were ages 35–55 was 14.3% among those who received housing assistance at the time of delivery, compared with 7.7% of patients who received housing assistance before delivery and 6.6% of those who received housing assistance after delivery.

The average maternal age among patients who received housing assistance was 26.6 years, compared with 29.4 for patients who did not receive housing assistance (Table 2). On average, patients who received housing assistance at delivery were age 27.4, compared with 25.4 or 25.3 for patients who received housing assistance before or after delivery, respectively.

Gestational age

Figure 4 shows the distribution of patients by gestational age at delivery and housing assistance status.

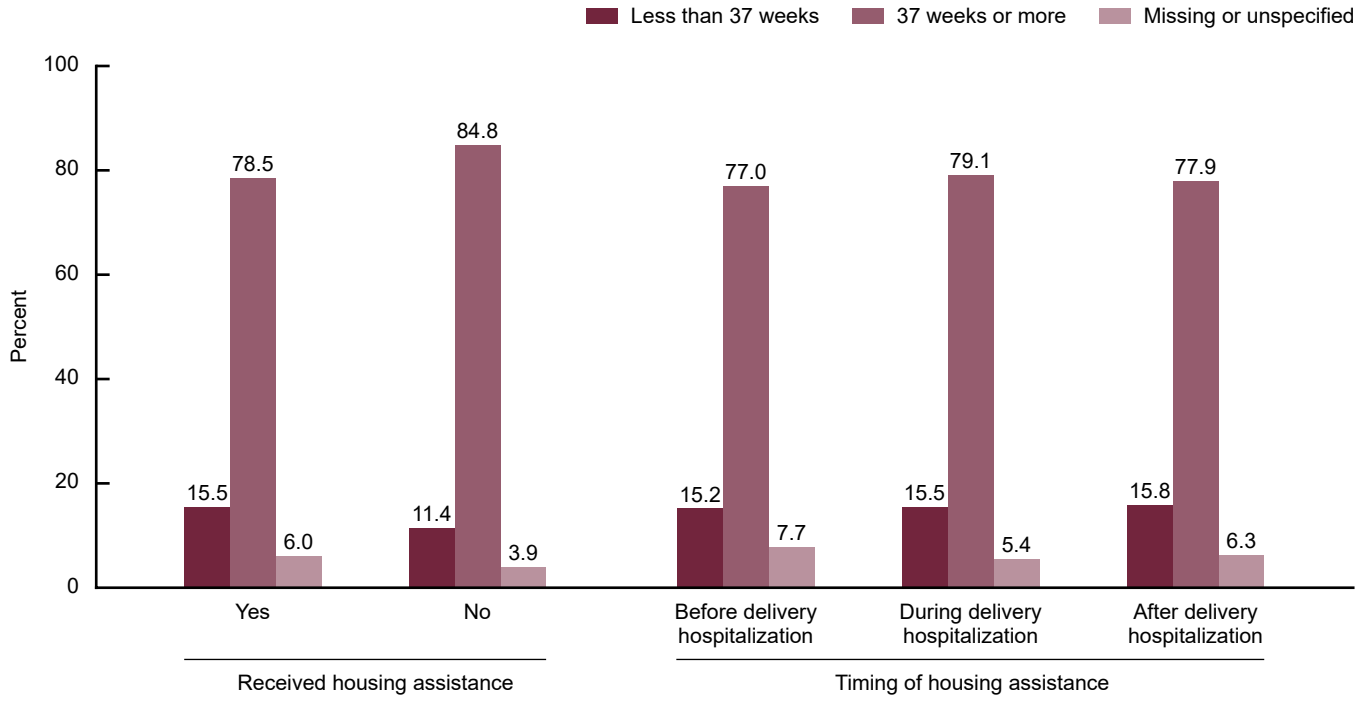
- Among patients who received housing assistance, 15.5% delivered at a gestational age of less than 37 weeks compared with 11.4% of patients who did not receive housing assistance.
- Among patients who did not receive housing assistance, 84.8% delivered an infant who was born at term or post-term compared with 78.5% of patients who received housing assistance.
- The percentage of patients delivering before 37 weeks of gestation was 15.2% among those who received housing assistance before delivery, compared with 15.5% among those who received housing assistance at the time of delivery and 15.8% among those who received housing assistance after delivery.
- Among patients who received housing assistance, 79.1% of those who received housing assistance at the time of delivery delivered at a gestational age of 37 weeks or more. In comparison, the percentages of patients who delivered at 37 weeks or more was 77.0% and 77.9% among patients who received housing assistance before or after delivery, respectively.

Patients who received housing assistance had an average gestational age of 37.8 weeks, while patients who did not receive housing assistance had an average gestational age of 38.2 weeks (Table 3). Patients who received housing assistance before or after delivery had an average gestational age of 37.7 weeks, while patients who received housing assistance at the time of delivery had an average gestational age of 37.8 weeks.

Severe maternal morbidity

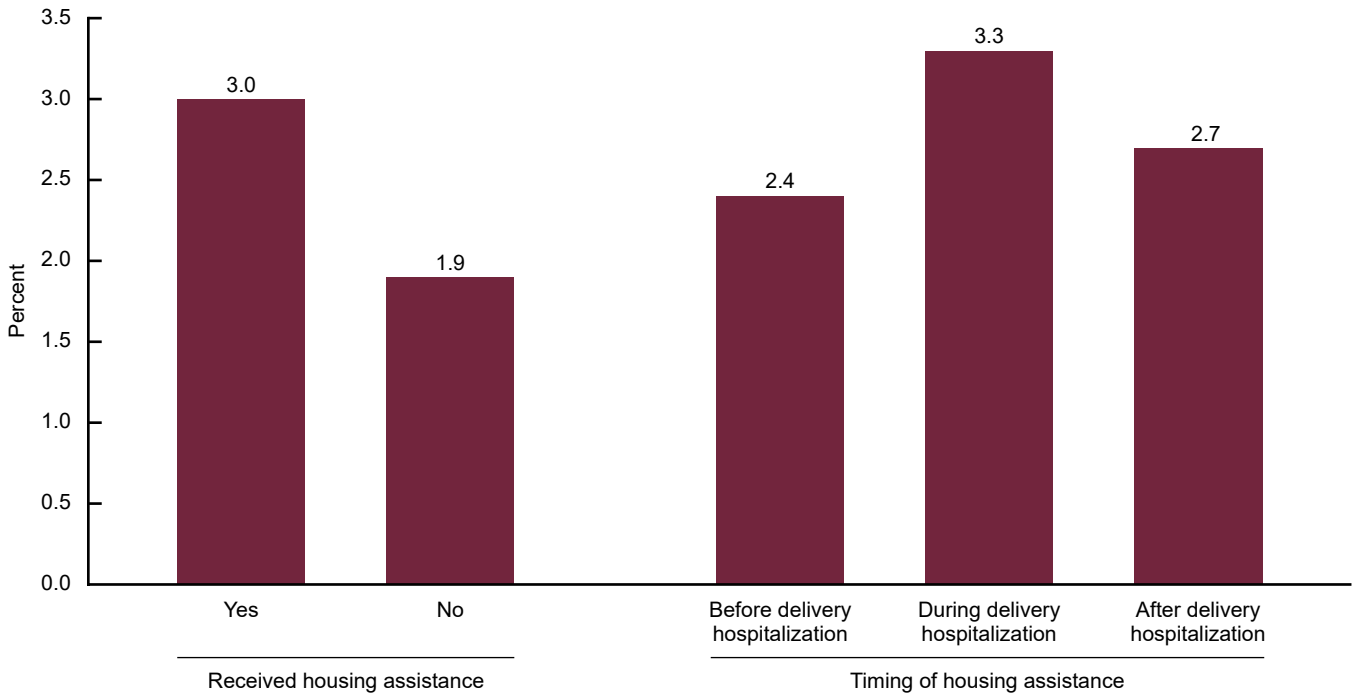
Figure 5 shows the percentage of patients who experienced SMM during their delivery hospitalization by housing assistance status.

Figure 4. Percentage of linkage-eligible patients, by gestational age group and housing assistance status: Linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data



NOTES: A total of 146,672 linkage-eligible patients had a delivery hospitalization in 2016, of whom 9,559 received housing assistance during 2015–2017—1,692 patients who had housing assistance before, 6,076 during, and 1,791 after their delivery hospitalization. Data are not nationally representative. Linkage-eligible patients are women ages 12–55 who had at least two patient identifiers and a delivery hospitalization in 2016.
SOURCE: National Center for Health Statistics, linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data.

Figure 5. Percentage of linkage-eligible patients with severe maternal morbidity, by housing assistance status: Linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data



NOTES: A total of 146,672 linkage-eligible patients had a delivery hospitalization in 2016, of whom 9,559 received housing assistance during 2015–2017—1,692 patients who had housing assistance before, 6,076 during, and 1,791 after their delivery hospitalization. Data are not nationally representative. Linkage-eligible patients are women ages 12–55 who had at least two patient identifiers and a delivery hospitalization in 2016.
SOURCE: National Center for Health Statistics, linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data.

- Three percent of patients who received housing assistance experienced SMM compared with 1.9% of patients who did not receive housing assistance.
- Among those who received housing assistance, 3.3% of patients with housing assistance at delivery experienced SMM. In comparison, the percentage of patients who experienced SMM was 2.4% and 2.7% among those who received housing assistance before or after delivery, respectively.

Delivery by cesarean section

Figure 6 shows the percentage of patients who had a cesarean delivery by housing assistance status.

- One-third of patients who received housing assistance delivered by cesarean section (33.3%) compared with 35.6% of patients who did not receive housing assistance.
- The percentage of patients delivering by cesarean section was 31.6% among those who received housing assistance before delivery, compared with 33.6% among those who received housing assistance at delivery and 33.7% among those who received housing assistance after delivery.

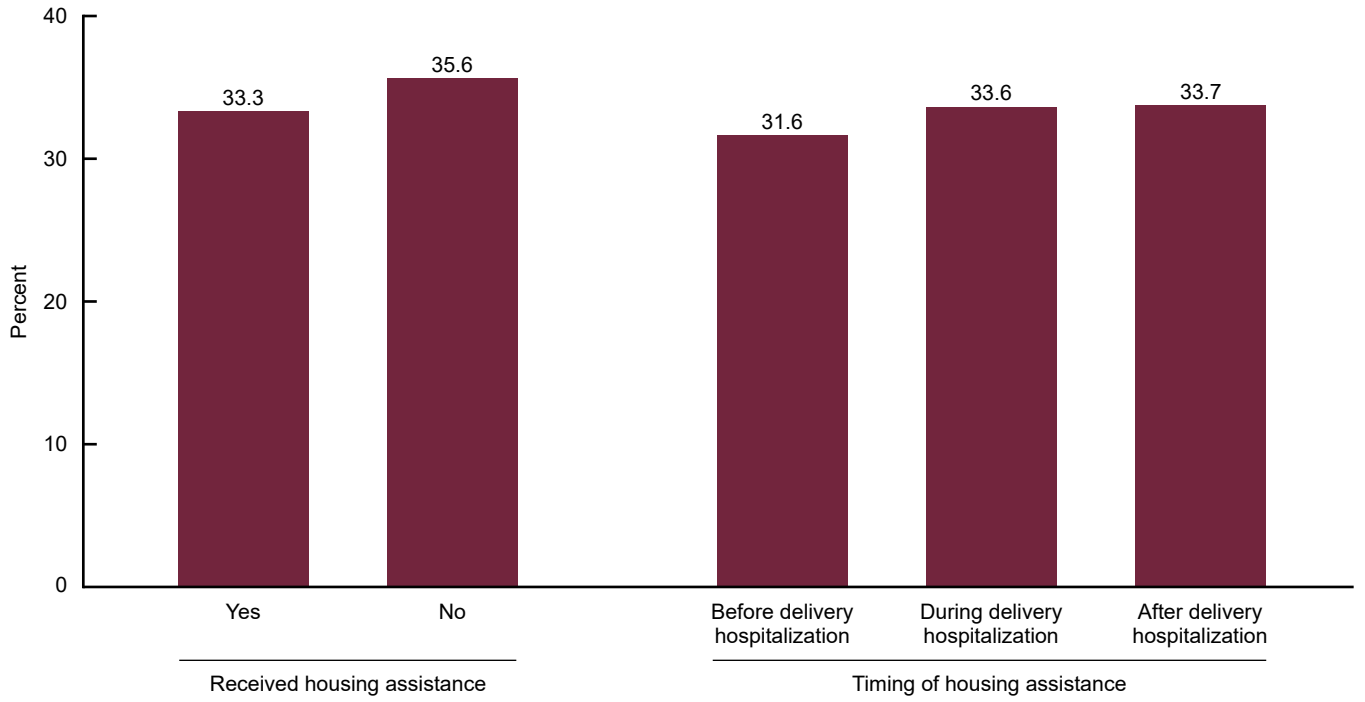
Regardless of housing assistance status, most patients who had cesarean deliveries had medically necessary cesarean sections (Table 4). The percentage of patients who had an emergent or medically indicated cesarean section was 90.1% among those who received housing assistance and 85.1% among those who did not receive housing assistance. Moreover, 91.1% of patients who received housing assistance at the time of delivery had medically necessary cesarean sections, compared with 89.2% of patients who received housing assistance before delivery and 87.4% of patients who received housing assistance after delivery.

Average length of stay

Regardless of housing assistance status, patients who delivered by cesarean section stayed in the hospital for nearly 4 days, while patients who had a vaginal delivery stayed in the hospital for 2.5 days on average (Table 5). For most groups except those receiving housing assistance after delivery, nearly 2% of patients were admitted to the ICU (Table 6).

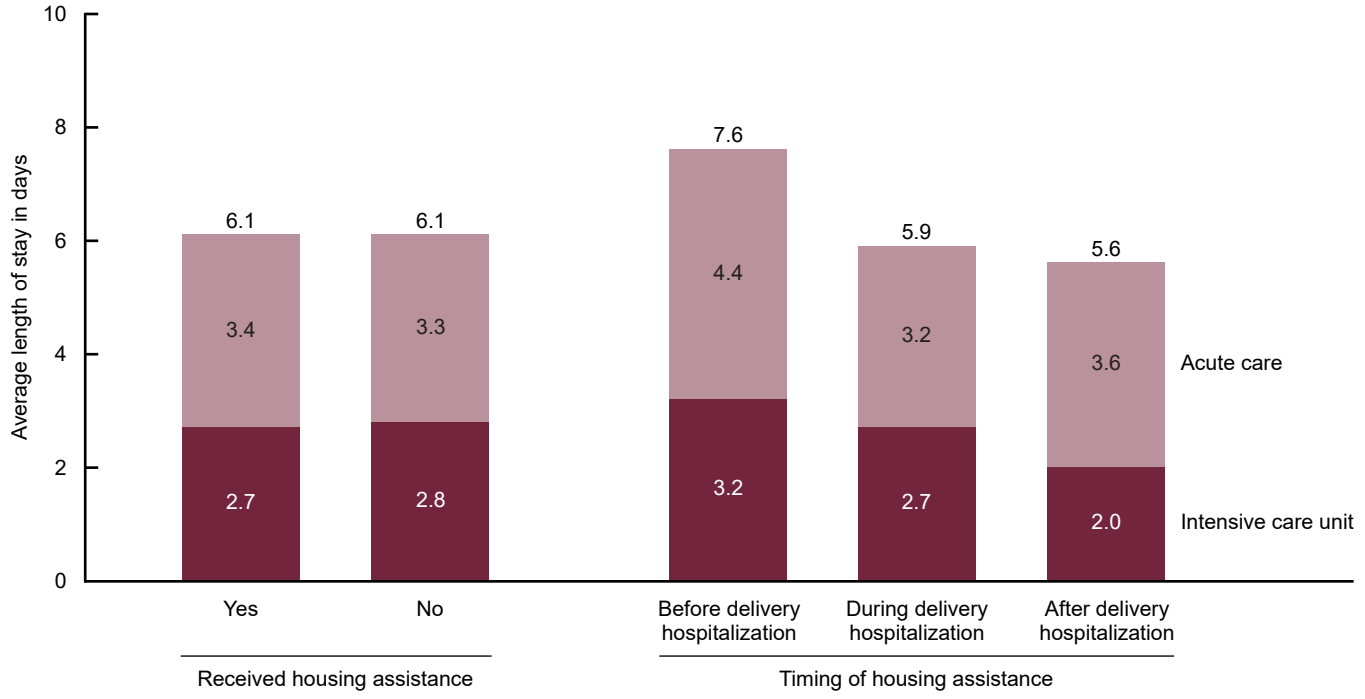
- Figure 7 shows the total average length of stay in the hospital for patients who were admitted to the ICU by housing assistance status, broken down by the average length of stay in acute care and in the ICU. Among patients admitted to the ICU, both those who received and did not receive housing assistance stayed in the hospital for a total average of 6.1 days.
- Average length of stay in the ICU was 2.7 days for those with housing assistance and 2.8 days for those without housing assistance. On average, patients who received housing assistance stayed in the

Figure 6. Percentage of linkage-eligible patients who delivered by cesarean section, by housing assistance status: Linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data



NOTES: A total of 146,672 linkage-eligible patients had a delivery hospitalization in 2016, of whom 9,559 received housing assistance during 2015–2017—1,692 patients who had housing assistance before, 6,076 during, and 1,791 after their delivery hospitalization. Data are not nationally representative. Linkage-eligible patients are women ages 12–55 who had at least two patient identifiers and a delivery hospitalization in 2016.
SOURCE: National Center for Health Statistics, linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data.

Figure 7. Total average length of stay in acute care and intensive care unit among patients admitted to intensive care unit, by housing assistance status: Linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data



NOTES: A total of 2,706 linkage-eligible patients had a delivery hospitalization in 2016 who were admitted to the intensive care unit, of whom 172 received housing assistance during 2015–2017—32 patients who had housing assistance before, 115 during, and 25 after their delivery hospitalization. Data are not nationally representative. Linkage-eligible patients are women ages 12–55 who had at least two patient identifiers and a delivery hospitalization in 2016.
SOURCE: National Center for Health Statistics, linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data.

acute care unit for 3.4 days, while patients who did not receive housing assistance stayed for 3.3 days.

- On average, patients who received housing assistance before delivery stayed in the hospital for a total of 7.6 days. Patients who received housing assistance at or after delivery stayed for a total of 5.9 days or 5.6 days, respectively.
- On average, patients who received housing assistance before delivery stayed in the ICU for 3.2 days, compared with 2.7 days for patients who received housing assistance at the time of delivery and 2.0 days for patients who received housing assistance after delivery. The average length of stay for patients in the acute care unit was 4.4 days, 3.2 days, and 3.6 days among those who received housing assistance before, at, or after delivery, respectively.

Discussion

This report examines delivery hospitalizations in the 2016 NHCS among both patients who received and did not receive housing assistance. In the 2016 NHCS, 146,672 patients had a delivery hospitalization and were eligible for linkage to 2015–2017 HUD administrative data. More than 95% of patients had a live birth, 1.0% had a stillbirth, and 3.4% were unspecified. Among this study population, 9,559 patients (6.5%) received housing assistance during 2015–2017. Nearly two-thirds of patients who received housing assistance from 2015 to 2017 were receiving housing assistance at the time of their delivery hospitalization (63.6%).

Regardless of housing assistance status, most patients delivered at hospitals located in large metropolitan areas, had a gestational age of about 38 weeks, and stayed in the hospital for an average of nearly 4.0 days for cesarean delivery and about 2.5 days for vaginal delivery. Just over 70% of patients who received housing assistance were insured by Medicaid compared with 35.6% of patients who did not receive housing assistance. Nearly 51% of patients who did not receive housing assistance were privately insured compared with 17.6% of patients who received housing assistance. The average maternal age at delivery was 26.6 years for patients who received housing assistance and 29.4 for patients who did not receive housing assistance. A total of 3.0% of patients who received housing assistance and 1.9% of patients who did not receive housing assistance experienced SMM.

Several limitations should be considered when interpreting the results of this report. Due to low participation among sampled hospitals, these linked data are not nationally representative. Consequently, comparisons of averages and percentages between groups were not evaluated using statistical testing, and reported results should not be generalized to all patients who had delivery hospitalizations at U.S. hospitals. Additionally, previous studies have highlighted the limitations of using the Centers for Disease Control and Prevention's SMM definition to identify delivery hospitalizations involving SMM; these limitations are detailed elsewhere (9).

Further, previous research demonstrates persistent maternal health disparities by race and ethnicity (22,23). However, housing assistance status and maternal health outcomes could not be examined by race and ethnicity in this report due to about 47% of delivery hospitalizations missing this information. Most delivery hospitalizations missing race and ethnicity data were from UB-04 administrative claims data submitted directly from sample hospitals. Additionally, 4.6% of delivery hospitalizations were missing health insurance coverage data, and 4.0% were missing gestational age data.

Previous research also has demonstrated high rates of health insurance coverage disruption before and after delivery hospitalizations (24,25). One study that analyzed 2005–2013 Medical Expenditure Panel Survey–Household Component data found that one-half of women who were uninsured before delivery had Medicaid or Children's Health Insurance Program coverage at delivery, but that 55% of women with this health insurance coverage at delivery were uninsured 6 months after delivery (24). Health insurance coverage before or after the delivery hospitalization could not be examined in this report because NHCS captures health insurance coverage data at the time of the delivery hospitalization.

Finally, a differential exposure time exists for examining housing assistance status based on when the delivery hospitalization occurred. For example, a patient who has a delivery hospitalization in January 2016 has 1 year before and 2 years after their delivery hospitalization to determine if they received housing assistance. In comparison, a patient who has a delivery hospitalization in December 2016 has 2 years before and 1 year after their delivery hospitalization to determine if they received housing assistance. Therefore, patients who had delivery hospitalizations earlier in 2016 may have had a higher chance of being classified into the after-delivery hospitalization group, and patients who had delivery hospitalizations later in 2016 may have had a higher chance of being classified into the before-delivery hospitalization group.

Conclusion

Despite these limitations, this report demonstrates how linked NHCS and HUD administrative data can be used to examine demographic characteristics and maternal health outcomes by housing assistance status. The findings demonstrate the type of information found in the linked NHCS and HUD administrative data and emphasize the possible analytical applications.

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Table 1. Percentage of linkage-eligible patients who received housing assistance: Linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data

Characteristic	Linkage-eligible patients
Received housing assistance:	Percent
Yes	6.5
No	93.5
Timing of housing assistance:	
Before delivery hospitalization	17.7
During delivery hospitalization	63.6
After delivery hospitalization	18.7

NOTES: A total of 146,672 linkage-eligible patients had a delivery hospitalization in 2016. Data are not nationally representative. Linkage-eligible patients are women ages 12–55 who had at least two patient identifiers and a delivery hospitalization in 2016.

SOURCE: National Center for Health Statistics, linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data.

Table 2. Average maternal age, by housing assistance status: Linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data

Characteristic	Average maternal age (years)
Received housing assistance:	
Yes	26.6
No	29.4
Timing of housing assistance:	
Before delivery hospitalization	25.4
During delivery hospitalization	27.4
After delivery hospitalization	25.3

NOTES: A total of 146,672 linkage-eligible patients had a delivery hospitalization in 2016. Data are not nationally representative. Linkage-eligible patients are women ages 12–55 who had at least two patient identifiers and a delivery hospitalization in 2016.

SOURCE: National Center for Health Statistics, linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data.

Table 3. Average gestational age, by housing assistance status: Linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data

Characteristic	Average gestational age (weeks)
Received housing assistance:	
Yes	37.8
No	38.2
Timing of housing assistance:	
Before delivery hospitalization	37.7
During delivery hospitalization	37.8
After delivery hospitalization	37.7

NOTES: Of the total146,672 linkage-eligible patients who had a delivery hospitalization in 2016, 5,877 (4.0%) were missing gestational age data. Data are not nationally representative. Linkage-eligible patients are women ages 12–55 who had at least two patient identifiers and a delivery hospitalization in 2016.

SOURCE: National Center for Health Statistics, linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data.

Table 4. Percentage of cesarean deliveries that were medically necessary, by housing assistance status: Linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data

Characteristic	Patients with medically necessary cesarean delivery
Received housing assistance:	Percent
Yes	90.1
No	85.1
Timing of housing assistance:	
Before delivery hospitalization	89.2
During delivery hospitalization	91.1
After delivery hospitalization	87.4

NOTES: Of the total 146,672 linkage-eligible patients who had a delivery hospitalization in 2016, 51,994 patients (35.4%) had a cesarean delivery. Data are not nationally representative. Linkage-eligible patients are women ages 12–55 who had at least two patient identifiers and a delivery hospitalization in 2016.

SOURCE: National Center for Health Statistics, linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data.

Table 5. Average length of hospital stay, by delivery type and housing assistance status: Linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data

Characteristic	Average length of hospital stay (days)	
	Cesarean section	Vaginal delivery
Received housing assistance:		
Yes	3.8	2.6
No	3.6	2.4
Timing of housing assistance:		
Before delivery hospitalization	3.8	2.6
During delivery hospitalization	3.8	2.5
After delivery hospitalization	3.9	2.6

NOTES: A total of 146,672 linkage-eligible patients had a delivery hospitalization in 2016. Data are not nationally representative. Linkage-eligible patients are women ages 12–55 who had at least two patient identifiers and a delivery hospitalization in 2016.

SOURCE: National Center for Health Statistics, linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data.

Table 6. Percentage of patients admitted to intensive care unit, by housing assistance status: Linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data

Characteristic	Patients admitted to intensive care unit
Received housing assistance:	Percent
Yes	1.8
No	1.8
Timing of housing assistance:	
Before delivery hospitalization	1.9
During delivery hospitalization	1.9
After delivery hospitalization	1.4

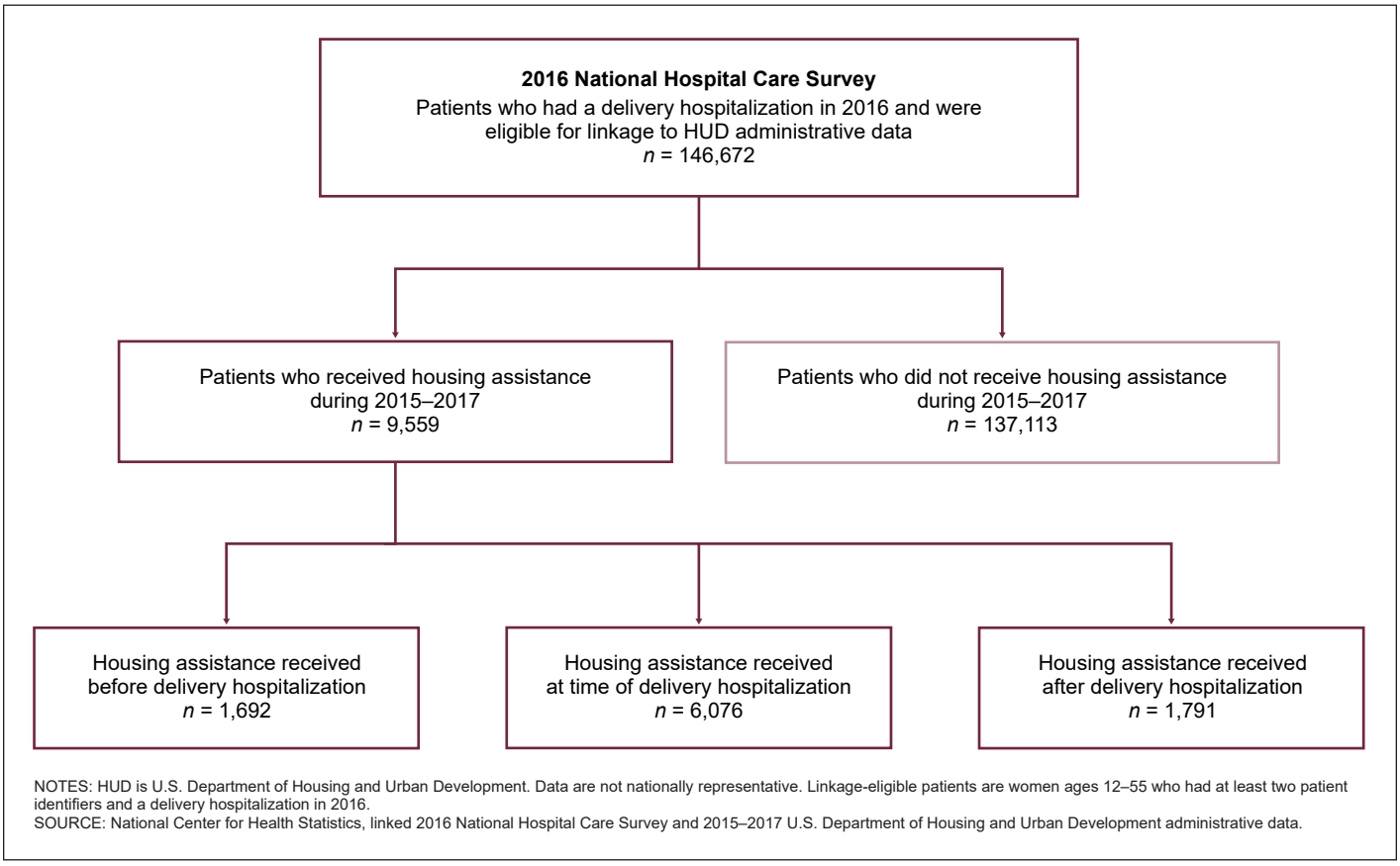
NOTES: Of the total 146,672 linkage-eligible patients who had a delivery hospitalization in 2016, 2,706 patients (1.8%) were admitted to the intensive care unit. Data are not nationally representative. Linkage-eligible patients are women ages 12–55 who had at least two patient identifiers and a delivery hospitalization in 2016.

SOURCE: National Center for Health Statistics, linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data.

Technical Notes

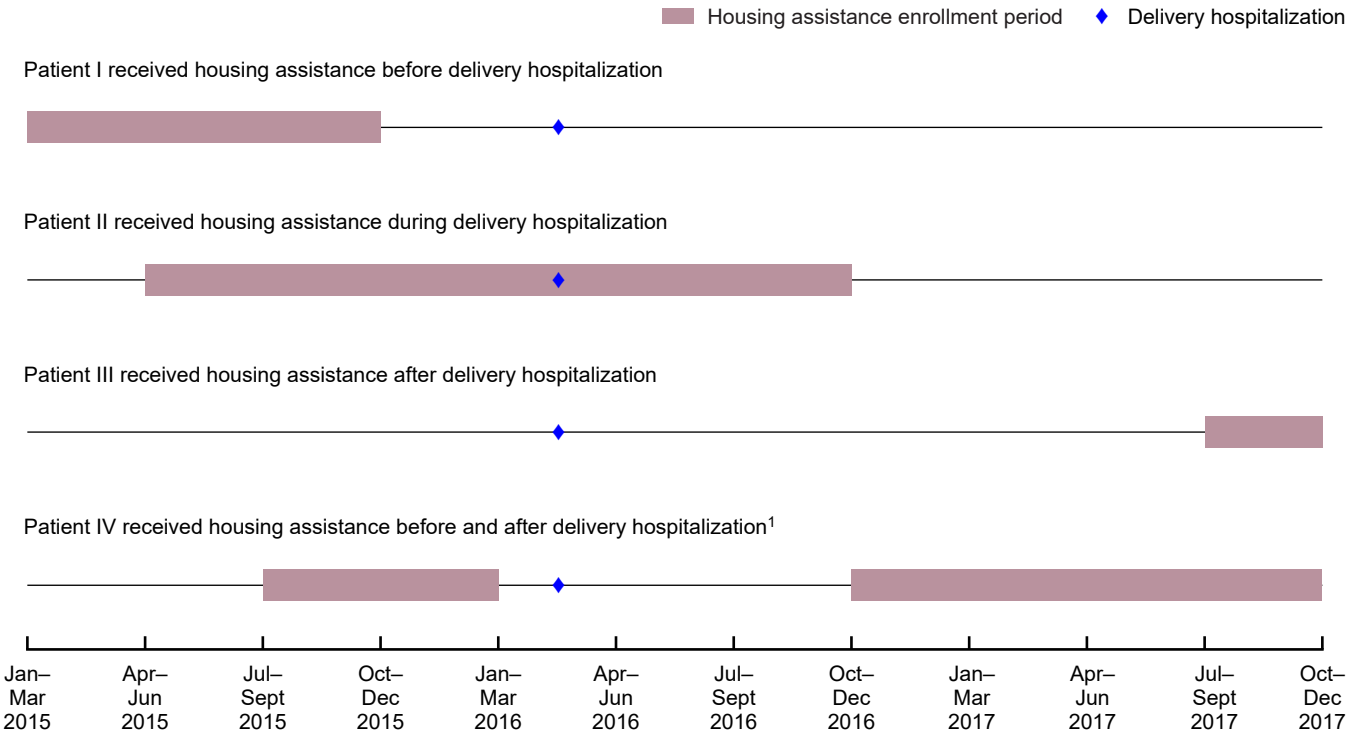
Supplemental figures and tables

Figure I. Study population for analysis



NOTES: HUD is U.S. Department of Housing and Urban Development. Data are not nationally representative. Linkage-eligible patients are women ages 12–55 who had at least two patient identifiers and a delivery hospitalization in 2016.
SOURCE: National Center for Health Statistics, linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data.

Figure II. Temporal alignment of housing assistance enrollment and delivery hospitalization



[1]Categorized as receiving housing assistance after hospitalization.
SOURCE: National Center for Health Statistics, linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data.

Table I. List of *International Classification of Diseases, Ninth Revision, Clinical Modification* and *International Classification of Diseases, 10th Revision, Clinical Modification* diagnosis codes indicating delivery hospitalization

Coding system and ICD short code	Description
ICD–9–CM	
V27	Outcome of delivery
ICD–10–CM	
Z37	Outcome of delivery
O60.1	Preterm labor with preterm delivery
O60.2	Term delivery with preterm labor
O67	Labor and delivery complicated by intrapartum hemorrhage, not elsewhere classified
O68	Labor and delivery complicated by abnormality of fetal acid-base balance
O69	Labor and delivery complicated by umbilical cord complications
O70	Perineal laceration during delivery
O75.5	Delayed delivery after artificial rupture of membranes
O75.81	Maternal exhaustion complicating labor and delivery
O75.89	Other specified complications of labor and delivery
O75.9	Complication of labor and delivery, unspecified
O77	Other fetal stress complicating labor and delivery
O80	Encounter for full-term uncomplicated delivery
O82	Encounter for cesarean delivery without indication

NOTES: ICD–9–CM is *International Classification of Diseases, Ninth Revision, Clinical Modification*. ICD–10–CM is *International Classification of Diseases, 10th Revision, Clinical Modification*.

SOURCE: National Center for Health Statistics, linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data.

Table II. List of *International Classification of Diseases, 10th Revision, Clinical Modification* diagnoses codes indicating severe maternal morbidity

Severe maternal morbidity indicator	*International Classification of Diseases, 10th Revision, Clinical Modification* short code
Acute myocardial infarction	I21.xx, I22.x
Aneurysm	I71.xx, I79.0
Acute renal failure	N17.x, O90.4
Adult respiratory distress syndrome	J80, J95.1, J95.2, J95.3, J95.82x, J96.0x, J96.2x, R09.2
Amniotic fluid embolism	O88.1x
Cardiac arrest or ventricular fibrillation	I46.x, I49.0x
Disseminated intravascular coagulation	D65, D68.8, D68.9, O72.3
Eclampsia	O15.x
Heart failure or arrest during surgery or procedure	I97.12x, I97.13x, I97.710, I97.711
Puerperal cerebrovascular disorders	I60—I68, O22.51, O22.52, O22.53, I97.81x, I97.82x, O87.3
Pulmonary edema or acute heart failure	J81.0, I50.1, I50.20, I50.21, I50.23, I50.30, I50.31, I50.33, I50.40, I50.41, I50.43, I50.9
Severe anesthesia complications	O74.0, O74.1, O74.2, O74.3, O89.0x, O89.1, O89.2
Sepsis	O85, O86.04, T80.211A, T81.4XXA, T81.44xx, OR R65.20, OR A40.x, A41.x, A32.7
Shock	O75.1, R57.x, R65.21, T78.2XXA, T88.2XXA, T88.6XXA, T81.10XA, T81.11XA, T81.19XA
Sickle cell disease with crisis	D57.0x, D57.21x, D57.41x, D57.81x
Air and thrombotic embolism	I26.x, O88.0x, O88.2x, O88.3x, O88.8x

SOURCE: National Center for Chronic Disease Prevention and Health Promotion.

Table III. List of *International Classification of Diseases, 10th Revision, Procedure Coding System* procedure codes indicating severe maternal morbidity

Severe maternal morbidity indicator	*International Classification of Diseases, 10th Revision, Procedure Coding System* code
Conversion of cardiac rhythm	5A2204Z, 5A12012
Blood transfusion	30233H1, 30233L1, 30233K1, 30233M1, 30233N1, 30233P1, 30233R1, 30233T1, 30233H0, 30233L0, 30233K0, 30233M0, 30233N0, 30233P0 30233R0, 30233T0, 30230H1, 30230L1, 30230K1, 30230M1, 30230N1, 30230P1, 30230R1, 30230T1, 30230H0, 30230L0, 30230K0, 30230M0 30230N0, 30230P0, 30230R0, 30230T0, 30240H1, 30240L1, 30240K1, 30240M1, 30240N1, 30240P1, 30240R1, 30240T1, 30240H0, 30240L0, 30240K0, 30240M0, 30240N0, 30240P0, 30240R0, 30240T0, 30243H1, 30243L1, 30243K1, 30243M1, 30243N1, 30243P1, 30243R1, 30243T1, 30243H0, 30243L0, 30243K0, 30243M0, 30243N0, 30243P0, 30243R0, 30243T0, 30250H1, 30250L1, 30250K1, 30250M1, 30250N1, 30250P1, 30250R1, 30250T1, 30250H0, 30250L0, 30250K0, 30250M0, 30250N0, 30250P0, 30250R0, 30250T0, 30253H1, 30253L1, 30253K1, 30253M1, 30253N1, 30253P1, 30253R1, 30253T1, 30253H0, 30253L0, 30253K0, 30253M0, 30253N0, 30253P0, 30253R0, 30253T0, 30260H1, 30260L1, 30260K1, 30260M1, 30260N1, 30260P1, 30260R1, 30260T1, 30260H0, 30260L0, 30260K0, 30260M0, 30260N0, 30260P0, 30260R0, 30260T0, 30263H1, 30263L1, 30263K1, 30263M1, 30263N1, 30263P1, 30263R1, 30263T1, 30263H0, 30263L0, 30263K0, 30263M0, 30263N0, 30263P0, 30263R0, 30263T0
Hysterectomy	0UT90ZZ, 0UT94ZZ, 0UT97ZZ, 0UT98ZZ, 0UT9FZZ
Temporary tracheostomy	0B110Z, 0B110F, 0B113, 0B114
Ventilation	5A1935Z, 5A1945Z, 5A1955Z

SOURCE: National Center for Chronic Disease Prevention and Health Promotion.

Table IV. List of *International Classification of Diseases, 10th Revision, Clinical Modification* diagnosis codes indicating obstetric, fetal, and maternal conditions that require or increase risk for cesarean delivery

ICD–10–CM[1] short code	Description
A60.00	Herpesviral infection of urogenital system, unspecified
A60.09	Herpesviral infection of other urogenital tract
O12	Gestational edema
O13	Gestational [pregnancy-induced] hypertension without significant proteinuria
O14.10	Severe pre-eclampsia, unspecified trimester
O15.9	Eclampsia, unspecified as to time period
O24.4	Gestational diabetes mellitus in pregnancy
O24.414	Gestational diabetes mellitus in pregnancy, insulin controlled
O24.43	Gestational diabetes mellitus in the puerperium
O24.439	Gestational diabetes mellitus in the puerperium, unspecified control
O26.4	Herpes gestationis in pregnancy
O30	Multiple gestation
O31.8X1	Other complications specific to multiple gestation, first trimester
O31.8X2	Other complications specific to multiple gestation, second trimester
O31.8X3	Other complications specific to multiple gestation, third trimester
O32.1	Maternal care for breech presentation
O32.2	Maternal care for transverse and oblique lie
O32.8	Maternal care for other malpresentation of fetus
O33.4XX0	Maternal care for disproportion of mixed maternal and fetal origin, not applicable or unspecified
O33.9	Maternal care for disproportion, unspecified
O34.21	Maternal care for scar from previous cesarean delivery
O43.2	Placenta accreta
O44.0	Placenta previa
O44.10	Placenta previa with hemorrhage, unspecified trimester
O44.30	Partial placenta previa with hemorrhage, unspecified trimester
O45.019	Premature separation of placenta with afibrinogenemia, unspecified trimester
O45.9	Premature separation of placenta, unspecified
O64.1	Obstructed labor due to breech presentation
O64.4	Obstructed labor due to shoulder presentation
O66.0	Obstructed labor due to shoulder dystocia
O66.4	Failed trial of labor
O66.5	Attempted application of vacuum extractor and forceps
O66.9	Obstructed labor, unspecified
O69.0XX0	Labor and delivery complicated by prolapse of cord, not applicable or unspecified
O69.0XX9	Labor and delivery complicated by prolapse of cord, other fetus
O75.0	Maternal distress during labor and delivery
O76	Abnormality in fetal heart rate and rhythm complicating labor and delivery
O77.0	Labor and delivery complicated by meconium in amniotic fluid
O77.1	Fetal stress in labor or delivery due to drug administration
O77.9	Labor and delivery complicated by fetal stress, unspecified
O98.71	Human immunodeficiency virus [HIV] disease complicating pregnancy
O98.719	Human immunodeficiency virus [HIV] disease complicating pregnancy, unspecified trimester
O99.81	Abnormal glucose complicating pregnancy, childbirth and the puerperium
Z36.88	Encounter for antenatal screening for fetal macrosomia
Z86.32	Personal history of gestational diabetes

[1]*International Classification of Diseases, 10th Revision, Clinical Modification*.

SOURCE: National Center for Health Statistics, linked 2016 National Hospital Care Survey and 2015–2017 U.S. Department of Housing and Urban Development administrative data.

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