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Reduced Rate of Postpartum Readmissions among Homeless Compared with Non-homeless Women in New York: A Population-Based Study Using Serial, Cross-Sectional Data

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Abstract

Objective: To assess differences in rates of postpartum hospitalizations among homeless women compared with non-homeless women.

Design: Cross-sectional secondary analysis of readmissions and emergency department (ED) utilization among postpartum women using hierarchical regression models adjusted for age, race/ethnicity, insurance type during delivery, delivery length of stay, maternal comorbidity index score, other pregnancy complications, neonatal complications, cesarean delivery, year fixed effect, and a birth hospital random effect.

Setting: New York statewide inpatient and emergency department databases (2009–2014).

Participants: 82,820 and 1,026,965 postpartum homeless and non-homeless women, respectively.

Main outcome measures: Postpartum readmissions (primary outcome) and postpartum ED visits (secondary outcome) within six weeks after discharge date from delivery hospitalization.

Results: Homeless women had lower rates of both postpartum readmissions (risk adjusted rates: 1.4% vs 1.6%; adjusted Odds Ratio [aOR] 0.87, 95% Confidence Interval [CI]: 0.75 to 1.00, p=.048) and ED visits than non-homeless women (risk adjusted rates: 8.1% vs 9.5%; aOR 0.83, 95%CI: 0.77 to 0.90, p<.001). A sensitivity analysis stratifying the non-homeless population by income quartile revealed significantly lower hospitalization rates of homeless women compared

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with housed women in the lowest income quartile. These results were surprising due to the trend of postpartum hospitalization rates increasing as income levels decreased.

Conclusions: Two factors likely led to lower rates of hospital readmissions among homeless women. First, barriers including lack of transportation, payment, or childcare could have impeded access to postpartum inpatient and emergency care. Second, given New York State's extensive safety net, discharge planning such as respite and sober living housing may have provided access to outpatient care and quality of life, preventing adverse health events. Additional research using outpatient data and patient perspectives is needed to recognize how the factors affect postpartum health among homeless women. These findings could aid in lowering readmissions of the housed postpartum population.

INTRODUCTION

Pregnancy and delivery account for approximately four million annual U.S. hospital admissions,(1) with 1-2% resulting in a postpartum readmission.(2-6) Hospitalizations reflect care-seeking behavior for more severe, costly conditions, serving as a global indicator of overall health and wellbeing.(7-12) Postpartum complications are a significant public health issue,(13) with social determinants of health contributing significantly to readmissions and inequity in quality of perinatal care.(14) Women experiencing homelessness face arduous challenges, with higher rates of chronic and acute illnesses(15) and risky behaviors that can result in adverse birth outcomes and delivery complications, impacting rates of postpartum readmissions.(16-19) Rates may reflect lower quality of care in some cases, as well as social exclusion, limited access to healthcare services and transportation,(15) poor daily health management, and hesitation in accessing timely services.(20-23) Current literature evaluating the risk of postpartum readmission among homeless women is limited.

Patient education before hospital discharge(8) and postpartum check-ups help limit readmissions.(9) The American College of Obstetricians and Gynecologists recommends a check-up within three weeks of delivery, and a comprehensive check-up by week twelve.(9) Most readmissions stem from medical conditions treatable in an outpatient setting if diagnosed in a timely manner.(24) Thus, evaluation of inequities in social determinants of health in perinatal care is critical to the improvement of patient and child health. For example, postpartum readmissions are lower among women with private insurance than uninsured women.(25) Most homeless women in the U.S. have public insurance or are uninsured.(26)

Pregnancy can also increase a woman's risk of homelessness,(16, 27, 28) with pregnancy among homeless women reportedly twice the rate (10%) of U.S. reproductive-age women.(29-31) Homeless women have a higher rate of co-morbidities, including preeclampsia.(32) Children born to homeless women risk lower birthweight and higher utilization of neonatal intensive care units than children born to non-homeless women.(18, 33-36)

In this study, we evaluated differences in rates of postpartum readmissions and emergency department (ED) visits within six weeks of delivery hospitalization discharge among postpartum homeless women compared with non-homeless women. We further explored

rates of postpartum readmissions and ED visits stratified by four income levels in a sensitivity analysis. ED visits could serve as a proxy for barriers to preventive care, resulting in readmissions. Low-income and homeless individuals utilize emergency services at a higher rate than their higher-income counterparts due to poor health management, limited access, and delayed care utilization.(20-23) Heightened awareness can help healthcare stakeholders develop and direct more effective interventions designed specifically for perinatal homeless women.

According to Department of Housing and Urban Development homeless population counts, 223,578 women experienced homelessness in 2020.(37) New York (NY) was selected for this analysis because of suitable coding quality of the homeless indicator and because it is home to the second largest female homeless population in the U.S. (18.7%), second only to California (23.9%).(37) Beginning in 2012, the NY State Department of Health's Office of Insurance Programs enrolled individuals experiencing homelessness into Medicaid Managed Care.(38) By streamlining Medicaid service access, some barriers were likely removed, but data regarding incentivization to seek services was not available.

METHODS

Database

We used 2009–2014 discharge data from the NY State Inpatient Databases (SID) and State Emergency Department Databases (SEDD), compiled by the Healthcare Cost and Utilization Project (HCUP), Agency for Healthcare Research and Quality (AHRQ).(39, 40) The SID and SEDD capture all inpatient discharge and ED discharge data, respectively, within NY. (41) Therefore, we were able to capture all eligible cases and track the same individuals, even if they utilized different healthcare facilities throughout the year. While 2016 data was the most recent available at the time of analysis, we chose to utilize years 2009–2014 as information regarding housing status was discontinued beginning in 2016(42), and 2015 data contained an unusually low number of patients who delivered and were coded as homeless. HCUP requires researchers to sign Data Use Agreements (DUAs), before data are released to them, prohibiting sharing or re-release of individual-level data. However, aggregate statistics and the statistical analysis plan are available below.

Identification of Patients

We identified delivery hospitalizations based on *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* codes, using previously described methodology.(43) Patients with an "H" listed under the zip code variable were categorized as "homeless."(42) Patients who had a numeric zip code listed for this variable were categorized as "non-homeless." We restricted our sample to patients who were coded as homeless and non-homeless patients with a numeric NY zip code.

We defined a postpartum readmission or ED visit within a six-week time frame after the discharge date of the delivery hospitalization, which corresponds roughly with the uterine involution period.(25, 44, 45) Since personal identifiers in HCUP datasets are not maintained across calendar years, we excluded women with delivery hospitalization

discharges in November or December. We excluded records without a unique identifier, and cases of deaths during delivery hospitalizations which would not have readmission records. Finally, we excluded women missing any of the following delivery hospitalization data: 1] race/ethnicity, 2] insurance type, 3] age, 4] length of stay (delivery-LOS) 5] discharge month, or 6] survival status. Delivery-LOS was necessary to number the days between delivery hospitalization discharge and the next readmission or ED visit, because HCUP provides the number of days between admissions. We included only the first delivery hospitalization for women who had multiple delivery hospitalizations, yielding a final analytic cohort of 1,109,785 women. (eTable 1)

Measurements

The primary exposure variable was homelessness. The primary outcome of interest was a binary variable indicating postpartum readmission within six weeks after the discharge date of the delivery hospitalization. The secondary outcome of interest examined women who had a postpartum ED visit.

Adjustment variables were based on previous studies(46-49) and included 1] age in quintiles (<23 years, 23–27 years, 28–30 years, 31–34 years, and >34 years); 2] race/ethnicity (non-Hispanic white, Black or African American, Hispanic, or other); 3] insurance type at delivery (public, private, self-pay, or other); 4] delivery-LOS as a categorical variable (≤1 day, 2 days, 3 days, 4 days, and ≥5 days), 5] maternal comorbidities, used to create a validated maternal comorbidity index score based on prenatal conditions(50) (maternal comorbidity index conditions listed in eTable 2); 6] other pregnancy complications;(25, 44) 7] neonatal complications (identified within maternal records using ICD-9-CM codes); 8] a binary variable to indicate cesarean delivery; 9] year, and 10] birth hospital ID. (Detailed adjustment variable information is provided in eTable 3). Delivery-LOS was included in the models to flag either potentially greater disease severity or more time under care to identify complications emerging during the delivery hospitalization or co-morbidities, which can influence need for follow-up care after discharge. Previous studies(51-53) reported a generally longer LOS among the homeless population. Additionally, an association between longer postoperative LOS and decreased risk for postpartum hypertension-related readmissions has been reported among women who delivered via cesarean section.(54) Therefore, impact of the delivery-LOS requires a necessary adjustment variable. We investigated the correlation between the maternal comorbidity index, other pregnancy complications, and method of delivery prior to the analyses. Additionally, although maternal age is part of the maternal comorbidity index score, we included it as a separate predictor in all models.

Analytic Approach

Descriptive statistics were tabulated and compared between homeless and non-homeless women using chi squared tests for categorical variables and t tests for continuous variables.

Multivariable logistic regression models were used to assess the primary and secondary outcomes (i.e., association between homelessness and postpartum readmissions, and association between homelessness and postpartum ED visits). All regression models

were adjusted by age, race/ethnicity, insurance type at delivery, delivery-LOS, maternal comorbidity index score, other pregnancy complications, neonatal complications, and a cesarean delivery indicator with a year fixed effect and birth hospital random effect. A birth hospital random effect was included because some women delivered at the same hospitals, which would lead to residual correlations and affect standard errors for estimates and p-values. We used marginal standardization(55) to calculate risk-adjusted rates for each outcome. After accounting for adjustment variable associations, we examined whether homelessness was associated with differences in postpartum readmissions. To do this, we performed likelihood ratio tests (LRTs) to compare models that included only adjustment variables with models that included homelessness as an adjustment variable, in addition to the ten adjustment variables listed above.

Sensitivity Analyses

Six sensitivity analyses were conducted. First, a delivery-LOS was included as a continuous variable in the model. Because it was positively skewed, we log-transformed delivery-LOS and included it in the model. Second, the majority of women in our sample had a delivery-LOS lasting between 2 and 4 days. Vaginal deliveries generally require a two-day stay.(56) According to a recent study by Federspiel et al.,(56) most U.S. women stayed between 2 and 3 days following uncomplicated cesarean sections (87.5%), with only 1.2% staying more than 4 days. Thus, we only included women with a delivery-LOS between 2 and 4 days. Wen et al.(54) reported that 90.6% of readmissions among women who underwent a cesarean delivery occurred within 10 days of discharge. We reassessed this interval for the current data, showing that most postpartum readmissions and ED visits occurred within 10 days after discharge. (eFigures 1-4) This second sensitivity analysis excluded women who had a long delivery-LOS (i.e., >4 days), who may have been kept in the hospital for conditions that would likely cause a readmission or ED visit. Third, to assess postpartum readmissions and ED visits for a longer period of observation, we included only women discharged from their delivery hospitalization in January, and evaluated primary and secondary outcomes during the next 11 months, rather than 6 weeks. Previous studies have reported that postpartum mortality due to suicidal behavior occurred later in the postpartum period.(57-59) Therefore, it was important to test whether our findings were sensitive to our choice of a six-week observation period following the discharge from delivery. Fourth, we included a birth hospital fixed effect, rather than a random effect, in the model because hospital characteristics may be causing the effect rather than homelessness. A hospital fixed effect controls all time-invariant factors, such as teaching status, profit status, bed size, etc. Fifth, HCUP's patient identifiers do not cross calendar years, which leaves opportunities to potentially include the same women multiple times if they had multiple deliveries between 2009 and 2014. Therefore, we conducted a sensitivity analysis using only 2014 data to minimize chances of using data from the same mother multiple times. Last, we categorized non-homeless women into four groups based on residential zip code-level median household income and included the income quartile variable in the model. We also estimated risk-adjusted rates of each outcome for each of the five categories, i.e., homeless women and the four income quartiles of non-homeless women, with the first quartile representing the lowest income group.

A two-sided p-value ≤0.05 was considered statistically significant. All analyses used SAS version 9.4. (SAS Institute, Inc., Cary, NC, USA).

Patient and Public Involvement

No patients were involved in setting the research question or outcome measures, or in developing plans for the design or implementation of the study. No patients were asked to advise on interpretation or writing of the results.

RESULTS

The analytic cohort included 82,820 homeless and 1,026,965 non-homeless women discharged alive after delivering babies between January and October from 2009–2014. The mean ages were 27.7 and 29.3 years among homeless and non-homeless women, respectively. Compared with non-homeless women, homeless women were less likely to be non-Hispanic white (3.6% vs 49.0%), more likely to be Black (32.4% vs. 14.2%), Hispanic (28.0% vs. 16.4%), or Other-race-identifying (36.0% vs. 20.4%), have public insurance (74.8% vs 44.2%) or self-pay which likely encompasses uninsured (23.8% vs 1.6%) and have higher rates comorbidities. For example, preeclampsia occurred more often among homeless women than non-homeless (4.7% vs 2.7% for mild preeclampsia and 2.3% vs 1.5% for severe preeclampsia or eclampsia) (all $p<.01$). (Table 1)

We found a strong correlation between preterm labor and early onset of delivery. Therefore, we created a composite binary variable, indicating “1” if preterm labor or early onset of delivery was recorded, or “0” if otherwise. (eTable 4) After adjusting by the variables listed above, we found that homeless women in NY’s SID and SEDD databases had lower risks of readmissions than non-homeless women within six weeks after delivery (risk-adjusted rates: 1.4%, 95% Confidence Interval [CI]: 1.2% to 1.6%, vs 1.6%, 95%CI 1.6% to 1.7%; adjusted Odds Ratio [aOR] 0.87, 95%CI: 0.75 to 1.00, $p=.048$). (Table 2 and 3) The same trend (i.e., a significantly lower risk) was observed among homeless compared with non-homeless women when we examined postpartum ED visits. (8.1%, 95%CI: 7.4% to 8.8% vs 9.5%, 95%CI: 9.0% to 10.1%; aOR 0.83, 95%CI: 0.77 to 0.90, $p<.001$). (Table 2 and 3) Results from the LRT showed that homelessness was meaningfully associated with differences in postpartum readmissions and ED visits. (eTable 5)

The results of all sensitivity analyses mirrored the direction of our main analyses, although differences were not always statistically significant. (Table 4) This is likely explained by decreased power due to the smaller samples included in the sensitivity analyses. When the non-homeless population was subcategorized into four groups based on residential zip-code-level median income, postpartum readmission and ED visit rates increased as the income level decreased. However, the homeless population had the lowest rates of readmission and ED visits, with statistically significant differences observed between the homeless population and housed women in the lowest income quartile for readmissions and between the homeless population and housed women in the lowest three income quartiles for ED visits. (Table 2 and 4; eFigure 5 and 6)

DISCUSSION

Our study's findings of significantly lower rates of readmissions and ED visits within six weeks after discharge from delivery hospitalization among postpartum homeless women compared to non-homeless women are unique. Literature reported higher rates of general hospitalizations and ED visits for other health conditions among the homeless population.(53, 60-63) Categorization of our non-homeless sample into quartiles based on zip code-level median household income demonstrated that postpartum readmissions and ED rates increased as income level decreased, yet rates among the homeless population did not follow this trend. This trend is likely indicative of a combination of contributing factors.

Homeless women face numerous barriers in their attempt to access and utilize healthcare services. NY expanded Medicaid benefits to low-income adults in 2000, but began transitioning homeless individuals and families onto Medicaid Managed Care plans starting in 2012.(38) However, 23.8% of our cohort lacked access, having no medical insurance at delivery. Obstacles to utilizing postpartum healthcare for homeless mothers, beyond securing food or housing, include distance to care coupled with lack of transportation, irregular insurance coverage, distrust due to poor treatment by providers, lack of childcare, low health literacy, and fear of being reported to Child and Family Services for homelessness or substance abuse.(64, 65) As a Medicaid recipient, homeless women also report a stigma associated with their insurance status,(66, 67) which can result in difficulties finding providers who accept Medicaid plans, and sometimes waiting upwards of four hours at a time to be seen.(66, 67)

Several studies have suggested reasons as to why individuals of a low socioeconomic status (SES) are generally expected to have higher rates of postpartum hospitalizations, compared with individuals of a higher SES.(25, 64, 68, 69) DiBari et al.(68) reported that lower-income women enrolled in Medicaid were more likely to skip postpartum care visits,(68) yet these women may be more at risk for health conditions that can result in postpartum readmissions. Clapp et al.(25) found that patients who experienced a postpartum readmission were more likely to be in the lowest income quartiles. Our own study resulted in similar findings to Clapp et al.(25) when we only evaluated the non-homeless population.

Physical and emotional barriers to scheduled postpartum care have also been cited among mothers in the general population. Bennett et al.(69) highlighted obstacles to the customary six-week postpartum check-up, such as: the mother's negative delivery experience and her sense of stress adjusting to her new role, infant health problems and difficulty adjusting to an infant's unpredictable schedule, apprehension surrounding additional healthcare related to the delivery, and a lack of appropriate services such as childcare. These barriers typically lead to poor health management at the outpatient setting, with limited access to postpartum follow-up care. It is also recognized that non-white patients often have unpleasant and even intimidating experiences with healthcare providers.(70, 71) Greater adverse experiences during delivery may occur among homeless populations marginalized because of their race or ethnicity and subsequently deter women from accessing postpartum follow-up care.(70, 71) Without care, a greater volume of readmissions or ED visits among women of a low SES are expected, compared with women of a higher SES. Conversely, our results for homeless

women, who are generally among the lowest SES, displayed an even lower trend of in terms of readmissions or ED visit volume.

Given this unexpected trend among postpartum homeless women, a second factor may be involved. Lower odds of readmissions and ED visits may be attributable to certain quality of care standards practiced by practitioners who accept Medicaid or agencies that advocate for the homeless, specifically in the state of NY. For instance, some organizations who treat homeless patients may have engaged in patient-centered comprehensive care.(72) In this case, care providers may have linked women with health and social services at discharge.(72) In fact, NY state has legislated waivers to its Medicaid managed care models for lower-income populations to provide respite and convalescent care, including women with more problematic deliveries and comorbidities.(73) As a result, even though homeless women may have been unable to stay in the hospital beyond the period medically needed, respite and convalescent care may have been available for more problematic deliveries.(73) Additionally, substance abuse services, including sober living homes, are often arranged for women with addictions who must attain or maintain sobriety to maintain custody of their infant.(74) These treatment and living facilities can improve homeless mothers' quality of life, and prevent adverse health events that lead to a postpartum readmission or ED visit. Moreover, this coordinated care effort may facilitate outpatient visits when needed. Khran et al.(75) reported that women experiencing homelessness who gave birth and subsequently needed to adapt to the needs of their child experienced high rates of poor mental health and/or substance use. In a systematic review, the authors found that housing programs implemented throughout the perinatal period were effective in improving the overall health of women.(75) The quality of care arising from NY's patchwork of comprehensive care programs may have reduced the need for postpartum hospitalization among homeless women.(72) Moreover, comprehensive care engages medical providers to improve patient outcomes by planning beyond the delivery hospitalization, facilitating coverage for later treatments in an outpatient setting.(72) If these connections prevented adverse health events, discharge planning and care coordination among this group could be applied to the low-income population, who had the highest postpartum readmission rate among non-homeless women. Additional qualitative research is needed to understand the quality of services homeless women in NY, and more broadly the U.S., have access to and utilize.

This study contained several limitations. First, our study focused only on NY databases. Therefore, results may not be generalizable to all states. Moreover, healthcare utilization was only measured through readmissions and ED visits, as outpatient data was not available. In addition, other than public information regarding NY's social service and medical care partnerships for homeless patients, utilization data for respite or sober living housing was unavailable. The NY data did not reflect the findings of Clapp et al.(5), who found minor readmission rates, which suggests postpartum readmission rates may be insignificant to the quality of perinatal care. However, the study by Clapp et al.(5) was not targeted to homeless women, examined 30-day readmissions after delivery rather than 42-day readmissions, and surveyed 21 states, many of which have hospitals with much lower facility volumes than NY state's average. We found a larger readmission rate than reported by Clapp et al.(5) i.e., median of 1.73% vs 1.06%. Additionally, our secondary outcome of postpartum ED

visit rates occurred more often than readmissions, but still mirrored the main analyses. Hospitalizations reflect care-seeking for more severe and costly health conditions and are often used as a global indicator of patient health and wellbeing for many different conditions.(7-12) Furthermore, ED services often serve as a primary source of care for low-income and homeless populations due to factors such as lack of health insurance or delays in seeking treatment until the condition cannot go unaddressed.(20-23) Therefore, we believe that readmissions and ED visits serve as a quality indicator, and the parallel of trends for readmissions and ED visits indicates robust findings.

Second, the postpartum period was defined from the delivery hospitalization discharge and not the delivery date, which could not be established for vaginal deliveries. We chose the discharge date, when a woman is considered able to continue rehabilitation on her own, for this six-week window, as often done in previous literature.(44)

Third, administrative datasets did not provide additional clinical detail beyond ICD-9-CM codes. We could not eliminate the risk of unmeasured confounders, such as number of previous births or parity, or limited demographic information in administrative databases. Length of homelessness was unavailable for our analyses, and we could not confirm definition(s) of homelessness used by EDs and hospitals. We designated women as homeless who were coded as homeless at the time of delivery. It is possible the homeless designation was incorrectly recorded. Women could have listed the address of extended family or friends they were staying with as their own. They did not consider themselves homeless, or wished to avoid the stigma, and were misclassified as non-homeless. However, it is unlikely that non-homeless individuals were coded as homeless. Therefore, the bias created from this misclassification is toward the null. A study from Massachusetts (MA) used linked emergency shelter usage data and Medicaid records and identified 2,384 deliveries per year. Assuming that the same proportion of deliveries to females experiencing homelessness that occurred in NY also occurred in MA, we would expect approximately 2,300 deliveries among homeless females per year in MA,(16) which supports the quality of homeless coding within the NY SID and SEDD during study years.

Fourth, we could not include eligible readmissions or ED visits that occurred outside NY or cases who died without being hospitalized or visiting an ED. We also could not determine whether some hospitals readmitted women pre-emptively during the postpartum period to prevent harm or deterioration that could befall them due to housing insecurity as they recovered physically.

Fifth, although we only included the first deliveries within the calendar year to avoid including the same individuals multiple times in the analyses, the same individuals could have been included more than once, as personal identifiers do not cross calendar years. Results of a sensitivity analysis designed to address this limitation by using only 2014 data showed similar differences between postpartum homeless and non-homeless women as the main analyses.

Last, we focused on healthcare utilization within six weeks after the delivery discharge. Although the postpartum period is defined as one year following delivery, personal

identifiers did not cross calendar years. Eleven months was the longest we could evaluate healthcare utilization, which is after a discharge in January. The sensitivity analysis evaluating postpartum readmissions and ED visits eleven months after delivery discharge demonstrated similar results to our main analyses. Additionally, the peak of readmissions occurred within the first ten days postpartum, as in other studies.(13, 24) Therefore, we believe our study focused on the most critical postpartum time period.

Our study revealed lower odds of postpartum readmissions or ED visits during the postpartum period among homeless women compared with non-homeless women in NY. Additional research is necessary to explore whether barriers prevent homeless women from utilizing services when needed or if more comprehensive postpartum care services in NY state has improved outcomes for postpartum homeless mothers. The next step will be to conduct interviews among postpartum women experiencing homelessness in NY, as well as to combine evidence from outpatient data with ED and hospital records. If interviews identify barriers in quality of care, or inequities within the homeless postpartum population, further research and collaboration with stakeholders in NY is needed to improve health outcomes. If output data and interviews show that additional services resulted in lower readmission and ED visit rates among homeless women compared to non-homeless women in our study, NY state's discharge planning and care coordination specific to the homeless population could become a model for comprehensive care among the non-homeless population, as well as for other states.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Individual Characteristics of NY Postpartum Women by Homeless Status

	Homeless (n=82 820)		Non-homeless (n=1 026 965)		*p-value*
	n	**%**	**n**	**%**	
Individual characteristics at delivery					
Age (Mean, SD)	27.7 (6.3)		29.3 (6.1)		<.001
Race/ethnicity					
Non-Hispanic white	2959	3.6%	502 785	49.0%	<.001
Black	26 853	32.4%	145 782	14.2%	<.001
Hispanic	23 158	28.0%	168 492	16.4%	<.001
Other	29 850	36.0%	209 906	20.4%	<.001
Insurance type during delivery					
Public	61 986	74.8%	453 964	44.2%	<.001
Private	1068	1.3%	534 358	52.0%	<.001
Self-Pay	19 718	23.8%	16 295	1.6%	<.001
Other	48	0.2%	22 348	2.2%	<.001
Length of Stay during delivery hospitalization					
Length of stay (Median, IQR)	3 (2,3)		3 (2,3)		<.001
≤1 Day	442	0.5%	39,231	3.8%	<.001
2 Days	35,363	42.7%	434,510	42.3%	.03
3 Days	31,481	38.0%	353,686	34.4%	<.001
4 Days	9,391	11.3%	135,436	13.2%	<.001
≥5 Days	6,143	7.4%	64,102	6.2%	<.001
Median household income in zip code					
Quartile 1 (lowest)	N/A	N/A	261 961	25.5%	N/A
Quartile 2	N/A	N/A	227 578	22.2%	N/A
Quartile 3	N/A	N/A	219 465	21.4%	N/A
Quartile 4 (highest)	N/A	N/A	306 027	29.8%	N/A
Maternal comorbidity					
Maternal Comorbidity Index (Mean, SD)	0.75 (0.75)		0.75 (1.19)		<.001
Alcohol abuse	98	0.1%	952	0.1%	.02
Asthma	1174	1.4%	17 122	1.7%	<.001
Cardiac valvular disease	96	0.1%	3855	0.4%	<.001
Chronic congestive heart failure	≤10 cases[a]		43	0.0%	.44
Chronic ischemic heart disease	≤10 cases[a]		187	0.0%	0.13
Chronic renal disease	317	0.4%	2542	0.3%	<.001
Congenital heart disease	43	0.1%	912	0.1%	<.001
Drug abuse	851	1.0%	13 794	1.3%	<.001
Gestational hypertension	1960	2.4%	25 103	2.4%	.16
Human immunodeficiency virus	≤10 cases[a]		≤10 cases[a]		.78
Mild preeclampsia or unspecified preeclampsia	3867	4.7%	27 358	2.7%	<.001

	Homeless (n=82 820)		Non-homeless (n=1 026 965)		*p-value*
	n	**%**	**n**	**%**	
Multiple gestation	1092	1.3%	22 404	2.2%	<.001
Placenta previa	546	0.7%	7115	0.7%	.26
Preexisting diabetes mellitus	934	1.1%	8512	0.8%	<.001
Preexisting hypertension	2251	2.7%	19 888	1.9%	<.001
Previous cesarean delivery	13 204	15.9%	174 823	17.0%	<.001
Pulmonary hypertension	25	0.0%	267	0.0%	.47
Severe preeclampsia/eclampsia	1896	2.3%	15 825	1.5%	<.001
Sickle cell disease	258	0.3%	2953	0.3%	.22
Systemic lupus erythematosus	86	0.1%	1618	0.2%	<.001
Outcomes at delivery					
Pregnancy complications					
Hemorrhage	5800	7.0%	74 448	7.3%	.008
Premature rupture of membranes	3966	4.8%	63 321	6.2%	<.001
Preterm labor	6409	7.7%	67 687	6.6%	<.001
Postpartum infection	2341	2.8%	13 201	1.3%	<.001
Uterine rupture	45	0.1%	836	0.1%	.008
Thrombotic event	480	0.6%	10 061	1.0%	<.001
Early onset of delivery	6409	7.7%	67 525	6.6%	<.001
Neonatal complications					
Fetal distress	163	0.2%	975	0.1%	<.001
Fetal growth restriction	1679	2.0%	21 052	2.1%	.66
Stillbirth	466	0.6%	4841	0.5%	<.001
Delivery Characteristics					
Cesarean delivery	24 474	29.6%	353 850	34.5%	<.001

[a]The observed number of cases was ≤10 and has therefore been masked to protect the privacy of the individual(s).

Table 2.

Adjusted Six-Week Postpartum Healthcare Utilization Rates[a]

	Adjusted Rate	95%CI[b]	
Postpartum Readmission [c]			
Homeless	1.4%	1.2%	1.6%
Non-homeless	1.6%	1.6%	1.7%
Postpartum ED visit [b]			
Homeless	8.1%	7.4%	8.8%
Non-homeless	9.5%	9.0%	10.1%
Postpartum Readmission [d]			
Homeless	1.4%	1.3%	1.7%
1st (lowest) income quartile	1.7%	1.6%	1.8%
2nd income quartile	1.6%	1.5%	1.7%
3rd income quartile	1.7%	1.6%	1.8%
4th (highest) income quartile	1.5%	1.4%	1.6%
Postpartum ED visit [d]			
Homeless	8.4%	7.7%	9.1%
1st (lowest) income quartile	10.3%	9.8%	10.9%
2nd income quartile	9.8%	9.2%	10.4%
3rd income quartile	9.2%	8.7%	9.8%
4th (highest) income quartile	8.6%	8.1%	9.1%

[a]Rates were adjusted by age, race/ethnicity, insurance type during delivery, delivery length of stay, maternal comorbidity index score, other pregnancy complications, neonatal complications, delivery characteristics, i.e., cesarean delivery, year fixed effect, and a birth hospital random effect

[b]Confidence Interval

[c]Comparing homeless and non-homeless utilization rates

[d]Non-homeless were divided into income quartiles based on zip code-level median income information

Table 3:

Regression Analyses[a] Results Evaluating Associations Between Six-Week Postpartum Healthcare Use in NY and Homelessness

	Number of events	Odds Ratio	95%CI[b]		*P*	Adjusted Odds Ratio	95%CI[b]		*P*
Primary Analysis									
Postpartum hospitalization									
Homeless	1,651	1.01	0.86	1.18	.17	0.87	0.75	1.00	.048
Non-homeless	18,524		Reference				Reference		
Secondary Analysis									
ED visit									
Homeless	11,876	1.15	1.06	1.25	<.001	0.83	0.77	0.90	<.001
Non-homeless	83,303		Reference				Reference		

[a]The regression models were adjusted by age, race/ethnicity, insurance type during delivery, delivery length of stay, maternal comorbidity index score, other pregnancy complications, neonatal complications, delivery characteristics, i.e., cesarean delivery, year fixed effect, and a birth hospital random effect

[b]Confidence Interval

Table 4.

Sensitivity Analyses[a] Evaluating Associations Between Six-Week Postpartum Healthcare Use in NY and Homelessness

	Adjusted Odds Ratio	95%CI[b]		P
Delivery-LOS was included as a log-transformed continuous variable [c]				
Postpartum readmission				
Homeless	0.86	0.75	0.99	.04
Non-homeless	Reference			
Postpartum ED visit				
Homeless	0.83	0.77	0.9	<.001
Non-homeless	Reference			
Only Women with a Delivery-LOS between 2-4 days [d]				
Postpartum readmission				
Homeless	0.90	0.78	1.03	.12
Non-homeless	Reference			
Postpartum ED visit				
Homeless	0.82	0.76	0.89	<.001
Non-homeless	Reference			
11 Month Follow-Up [e]				
Postpartum readmission				
Homeless	0.83	0.62	1.11	.21
Non-homeless	Reference			
Postpartum ED visit				
Homeless	0.85	0.69	1.03	.10
Non-homeless	Reference			
Hospital Fixed Effect [f]				
Postpartum readmission				
Homeless	0.85	0.70	1.04	.11
Non-homeless	Reference			
Postpartum ED visit				
Homeless	0.82	0.75	1.89	<.001
Non-homeless	Reference			
Only 2014 Records [g]				
Postpartum readmission				
Homeless	0.82	0.67	1.01	.06
Non-homeless	Reference			
Postpartum ED visit				
Homeless	0.74	0.62	0.88	<.001
Non-homeless	Reference			
Non-Homeless Income Quartiles [h]				

	Adjusted Odds Ratio	95%CI[b]		P
Postpartum readmission				
Homeless	Reference			
1st (lowest) income quartile	1.18	1.02	1.36	.02
2nd income quartile	1.11	0.96	1.28	.15
3rd income quartile	1.14	0.98	1.31	.08
4th (highest) income quartile	1.04	0.90	1.21	.57
Postpartum ED visit				
Homeless	Reference			
1st (lowest) income quartile	1.26	1.17	1.37	<.001
2nd income quartile	1.19	1.10	1.29	<.001
3rd income quartile	1.11	1.03	1.21	.009
4th (highest) income quartile	1.03	0.95	1.11	.53

[a]The regression models were adjusted by age, race/ethnicity, insurance type during delivery, delivery length of stay, maternal comorbidity index score, other pregnancy complications, neonatal complications, delivery characteristics, i.e., cesarean delivery, year fixed effect, and a birth hospital random effect

[b]Confidence Interval

[c]Delivery-LOS data was positively skewed. To correct this, delivery-LOS was log-transformed and included in the model as a continuous variable

[d]Only women with a delivery-LOS between 2–4 days were included in the model. Delivery-LOS was included as a categorical variable

[e]Women who delivered in January during the study period (i.e., 2009–2014) were followed for 11 months to examine their postpartum readmissions and ED visits

[f]Hospital IDs were included as a fixed effect, rather than a random effect, in the model

[g]Since personal identification numbers do not carry across calendar years, we included only records of women who delivered in 2014, to avoid potentially counting individuals who delivered multiple times over the study period (i.e., 2009–2014) more than once

[h]Non-homeless individuals were divided into income quartiles based on zip code-level median income information