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RESEARCH ARTICLE

Pregnancy and Emergency Department Utilization in North Carolina, 2016–2021: A Population-Based Surveillance Study

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Introduction: Pregnancy-associated complaints are a common reason for emergency department visits for women of reproductive age. Emergency department utilization during pregnancy is associated with worse birth outcomes for both mothers and infants. We used statewide North Carolina emergency department surveillance data between 2016 and 2021 to describe the sociodemographic factors associated with the use of emergency department for pregnancy-associated problems and subsequent hospital admission.

Methods: North Carolina Disease Event Tracking and Epidemiologic Collection Tool is a syndromic surveillance system that includes all emergency department encounters at civilian acute-care facilities in North Carolina. We analyzed all emergency department visits between January 1, 2016 and December 31, 2021 for female patients aged 15–44 years residing in North Carolina with at least 1 ICD-10-CM code (analysis occurred in July 2021–October 2022). Each emergency department visit was categorized as pregnancy-associated if assigned ICD-10-CM code(s) indicated pregnancy. We stratified visits by age, race, ethnicity, county of residence, and insurance and compared them with estimated pregnant population proportions using 1-sample *t*-tests. We used multivariable logistic regression to determine whether pregnancy-associated visits were more likely to be associated with hospital admission and then to determine sociodemographic predictors of admission among pregnancy-associated emergency department visits.

Results: More than 6.4 million emergency department visits were included (N=6,471,197); 10.1% (*n*=655,476) were pregnancy-associated, significantly higher than the proportion of women estimated to be pregnant at any given time in North Carolina (4.6%, $p<0.0001$) and increased over time (8.6% in 2016 vs 11.1% in 2021, $p<0.0001$). Pregnancy-associated visits were lower than expected for ages 25–44 years and higher than expected for those aged 15–24 years, for those of Black race, and for patients residing in rural or suburban areas. The proportion admitted was higher for pregnancy-associated emergency department visits than for nonpregnancy associated (15.6% vs 7.0%, AOR=3.06 [95% CI=3.03, 3.09]). Pregnancy-associated emergency department visits for patients of Black race had 0.58 times (95% CI=0.57, 0.59) the odds of admission compared with White patients.

Conclusions: Emergency department utilization during pregnancy is common. The proportion of pregnancy-associated emergency department visits among reproductive-age women is increasing,

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2773-0654/$36.00
https://doi.org/10.1016/j.focus.2023.100142

as are inpatient admissions from the emergency department for pregnancy-associated diagnoses. Use of public health surveillance databases such as the North Carolina Disease Event Tracking and Epidemiologic Collection Tool may help identify opportunities for improving disparities in maternal health care, especially related to access to care.

INTRODUCTION

Maternal morbidity and mortality continue to increase in the U.S.[1] Large disparities in maternal mortality continue to exist in the U.S.—there is a twofold to threefold higher risk of pregnancy-related deaths for non-Hispanic Black and American Indian individuals than for non-Hispanic White individuals.[2–4] People living in rural areas of the U.S. also have a 50% higher risk of death due to pregnancy than those living in urban areas.[2] In North Carolina (NC)—where 80 of 100 counties are rural, Medicaid was not expanded, and 25 rural counties were without a single obstetrics–gynecology physician in 2019—there remain barriers to accessing high-quality maternal health care, and these are likely related to ongoing disparities in maternal mortality and morbidity.[3,5–7]

Emergency departments (EDs) are a common entry point into the U.S. healthcare system for many patients, including pregnant individuals who may be unable to access care elsewhere or who may have an urgent medical concern that cannot be cared for during regular business hours.[8] In a study of Medicaid claims data from 2008 to 2009 in NC, pregnancy-specific complaints were one of the most frequent reasons for ED visits among pregnant individuals.[9] In that study, over 50% of patients visited an ED at least once during pregnancy, and 18% received emergency care ≥4 times.[9] Women with inadequate prenatal care or chronic health conditions are more likely to seek ED care during pregnancy.[8,10] ED utilization during pregnancy is also associated with worse birth outcomes for both mothers and infants.[11] In a study of postpartum patients in Michigan, patients who utilized the ED at least once during pregnancy had a higher likelihood of delivering a preterm infant and developing postpartum depression than those who did not use the ED.[11] According to a recent Canadian study, ED use during pregnancy may indicate poor access to care but may also identify people at higher risk of maternal and infant morbidity and mortality.[12] A better understanding of ED use during pregnancy may help stakeholders to develop strategies for prevention of maternal and infant morbidity and mortality and disparities in them before they occur.

To better understand how to care for all pregnant patients in a way that both improves the quality of their care and avoids potentially preventable maternal morbidity within the state of NC, it is essential to better understand ED utilization during pregnancy and describe any disparities using a more recent and comprehensive data set. Prior studies have been limited in scope by type of insurance, a subset of hospitals, or historical records. When we investigate this topic only through a specific lens (e.g., privately insured, Medicaid insured, limited to 1 hospital system), important parts of the picture can be unintentionally left out.

NC ED surveillance data from the North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT) are a comprehensive public health surveillance registry of >99% of all ED visits in NC. We aimed to use this data set to determine, among women of reproductive age (WRA) in 2016–2021, (1) whether ED utilization for pregnancy-associated concerns has been changing despite nonincreasing NC pregnancy rates, (2) whether certain sociodemographic groups over or underutilized the ED for pregnancy-associated concerns compared with expectations based on NC pregnancy rates, (3) whether pregnancy-associated visits were associated with a higher chance of admission than nonpregnancy-associated visits, and (4) whether certain sociodemographic characteristics were more predictive of admissions for pregnancy-associated visits. Furthermore, the data analyzed in this study are collected in real time for public health surveillance. An overarching goal of this study is to provide a proof of concept for using NC DETECT or similar ED surveillance systems to inform public health priorities and interventions for maternal health and maternal health disparities.

METHODS

Study Sample

NC DETECT is a syndromic surveillance system that includes all ED encounters at civilian acute-care facilities

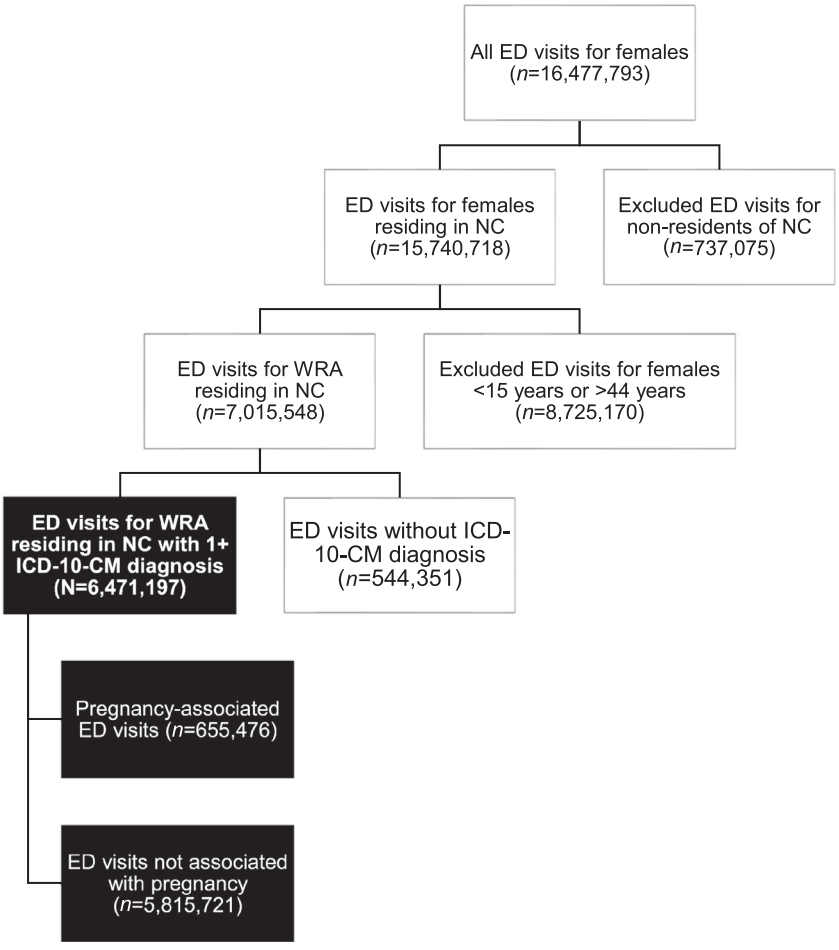

Figure 1. Study flow diagram of ED visits in NC among women aged 15–44 years from January 1, 2016 to December 31, 2021.
Pregnancy-associated ED visits are defined as ED visits with ICD-10-CM diagnosis code(s) that indicate current or recent pregnancy.[14,16] WRA are those aged 15–44 years.
ED, emergency department; NC, North Carolina; WRA, women of reproductive age.

across NC, with associated demographic data, reasons for visits, and diagnosis codes.[13] This includes >99% of all ED visits at the civilian hospitals in NC. The data are used primarily for public health surveillance and early event detection. We analyzed a limited data set of ED visit data collected through NC DETECT for WRA (aged 15–44 years), as defined by the Centers for Disease Control and Prevention (CDC).[14] Our study sample included all ED visits by female patients of reproductive age residing in NC with at least 1 International Classification of Disease (ICD) code of any kind associated with the visit between January 1, 2016 and December 31, 2021 (N= 6,471,197) (Figure 1).[17] Given the reliance on ICD-10-CM coding for this study, we opted to include data from 2016 and beyond to avoid potential differences in classification that may happen if visits before and during the International Classification of Disease, Ninth Revision, Clinical Modification/ICD-10-CM transition in 2015 was used. This study obtained an exemption from human subjects review from the University of North Carolina at Chapel Hill IRB.

Measures

All data used were collected by NC DETECT. Age was available by year, and we classified patient age into 6 categories that correspond with groupings commonly used by the National Center for Health Statistics (NCHS) and CDC: 15–19 years, 20–24 years, 25–29 years, 30–34 years, 35–39 years, and 40–44 years. Patient race was classified into 5 categories that correspond to those used by the NCHS: American Indian, Asian or Pacific Islander, Black or African American, Other, and White. NC DETECT provides Asian and Pacific Islander as separate categories, but we combined them for comparison with NCHS data. In 2021, NC DETECT began including more specificity for descriptions of race, but to stay

consistent with the previous years and to allow for comparison with other NCHS data, we grouped European, Hispanic or Latin American, and Middle Eastern as other. Patient ethnicity was classified into 2 categories: Hispanic origin and not of Hispanic origin. Using the county of residence of the patient, we then used population densities defined by The NC Rural Center 2015 Impacts Report with 2014 U.S. Census population figures to classify residence type into 3 categories: rural, suburban, and urban.[15] Insurance payer was classified into 5 categories by NC DETECT: Medicaid, non-Medicaid government payer, private insurance, self-pay, and other. Other includes ED visits with no charge and those for worker's compensation. We used insurance payer as a proxy marker for various social determinants of health in our analysis by dichotomizing it into 2 categories: Medicaid and non-Medicaid.[16]

Pregnancy-associated ED visits were identified by the presence of 1 or more ICD-10-CM diagnosis code(s) that indicated current or recent pregnancy (n=655,476).[17,18] This included all diagnoses beginning with O (obstetrics) as well as Z34 (routine antenatal care) and/or Z33 (pregnancy incidental).[17]

NC DETECT provides multiple categories of ED visit dispositions, including admitted, died, discharged, left against medical advice or without being seen, observation, transfer to another hospital, transfer to other health care, and others. Transfer to other health care includes transfers and discharges to a skilled nursing facility, intermediate care facility, certified home care, or other types of institution, excluding prison or jail or other hospital. We classified each visit as ending in admission or not, with transfer to another hospital considered an admission.

Statistical Analysis

ED visits were categorized as pregnancy-associated or not pregnancy-associated. After stratifying pregnancy-associated ED visits according to age, race, ethnicity, county of residence, insurance payer, and ED disposition, raw proportions were calculated. Subsequently, proportions for demographics (i.e., all but ED disposition) were compared with estimated proportions expected to be pregnant at any given time using NCHS data and an algorithm recommended by the CDC.[14,19] The proportions of ED visits with a pregnancy-associated diagnosis were compared with the proportion of women in NC estimated to be pregnant at any given time using 1-sample t-tests.

Demographic characteristics independently associated with pregnancy-associated ED visits were identified using multivariable logistic regression. The covariates in this analysis were limited to those available in NC DETECT and included visit year, age group, race, ethnicity, type of county of residence (rural, suburban, and urban), and Medicaid status. Multivariable logistic regression was used to analyze whether the pregnancy-associated status of an ED visit was independently associated with admission to a hospital. The covariates for that analysis were the same as used in the previous analysis, with the inclusion of more specific categories for insurance payer. Model performance was evaluated using receiver operating characteristic curve analysis. To evaluate the potential impact of lack of independence of observations on our logistic regression results, we completed a sensitivity analysis with the same model filtered to include the first visit for an individual patient according to the unique Internal Tracking Identification before reperforming the analysis.

A 1-sided $p<0.05$ was considered statistically significant. Associations are presented as AORs with corresponding 95% CIs. All analysis was conducted using SAS, Version 9.4 (SAS Institute, Cary, NC) from July 2021 to October 2022. NC DETECT data are provided upon request through a Data Use Agreement. Our code is available online at https://github.com/ncdetectpregnancy.

RESULTS

More than 6.4 million ED visits met our inclusion criteria (N=6,471,197) between 2016 and 2021(Figure 1). ED visits with an ICD-10-CM code associated with pregnancy made up 10.1% (n=655,476) of ED visits for WRA. This is significantly higher than the proportion of women estimated to be pregnant at any given time in NC (4.6%, $p<0.0001$) (Appendix Table 1, available online).[14,19,20] Furthermore, the proportion of pregnancy-associated ED visits increased significantly each year (AOR=1.06; 95% CI=1.05, 1.06) (Figure 2). To understand whether the ED visit was only incidental to pregnancy or actually related to pregnancy, we determined that only 3.2% of the pregnancy-associated visits used an incidental pregnancy code (Z33), meaning that over 96% of the pregnancy-associated visits appeared to be directly related to the pregnancy itself. Demographic characteristics of the visits are reported in Table 1. For visits with a known payer, Medicaid covered 52.0% of pregnancy-associated visits, in contrast to only 35.6% of all ED visits for WRA (Table 1).

The mean age of patients seen for a pregnancy-associated ED visit was approximately 3 years younger than the mean age for all ED visits by WRA (26.6 ± 5.9 years vs 29.4 ± 8.0 years) (Table 1). The age distribution was also different, with 59.6% of pregnancy-associated ED visits occurring for patients aged between 20 and 29 years versus 39.4% for all ED visits by WRA.

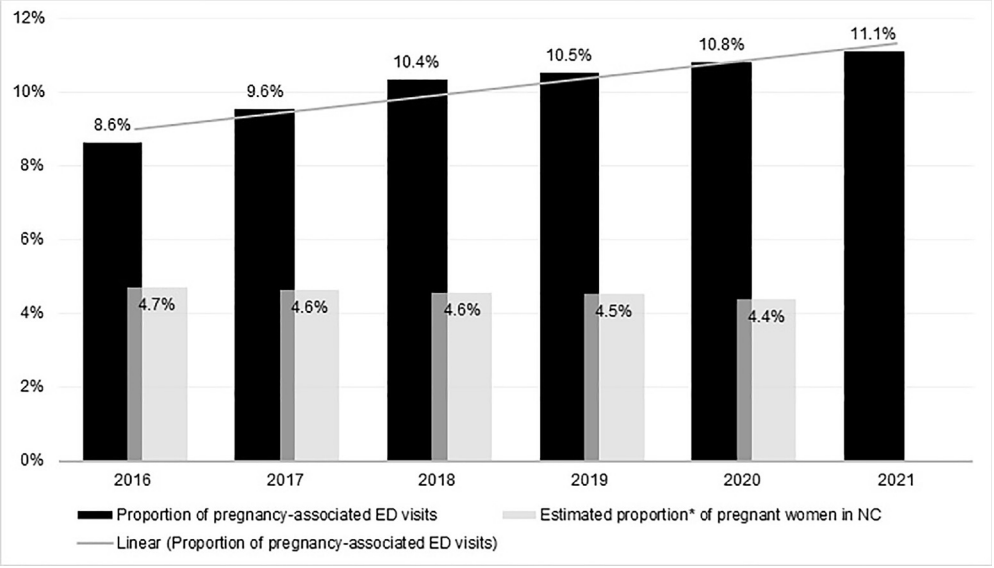

Figure 2. ED utilization for pregnancy-associated concerns among women of reproductive age in NC from 2016 to 2021.
Also shown are the proportions of pregnancy among NC reproductive-age women. The asterisk (*) denotes the estimated proportion calculated using data from the NC State Center for Health Statistics and the Pacific formula developed by the CDC for pregnancy estimation; 2021 estimates were not yet available at the time of analysis.[14,19]
CDC, Centers for Disease Control and Prevention; ED, emergency department; NC, North Carolina.

On bivariate analysis, higher than expected proportions of pregnancy-associated ED visits were found for women in the following groups: women aged between 15 and 24 years, women of Black or African American race, those not of Hispanic origin, and those with rural or suburban counties of residence as well as those not insured by Medicaid (Table 2). Conversely, significantly lower than expected proportions of pregnancy-associated ED visits were seen for women in these groups: those aged between 25 and 44 years, women of American Indian race, women of Asian or Pacific Islander race, women of White race, women of Hispanic origin, those with urban counties of residence, and those insured by Medicaid (Table 2).

In the fully adjusted model evaluating the odds of an ED visit being pregnancy-associated, we were unable to adjust for the proportion of the population that is pregnant for each demographic subgroup, and so we chose to not report them. Full results detailing the odds of an ED visit being pregnancy-associated and subsequent sensitivity analysis are available in Appendix Tables 2 and 3 (available online).

On average, 7.0% of ED visits for all WRA ended in an admission between 2016 and 2021, whereas 15.5% of pregnancy-associated ED visits resulted in an admission (Appendix Figure 1, available online). This rate of admission for pregnancy-associated visits increased over the study period, peaking at 19.0% in 2020 (14.2% in 2016 vs 15.1% in 2021) (Appendix Figure 1, available online).

In the multivariable model of pregnancy-associated visits only, we also found that the odds of admission were highest during 2020, significantly higher than the odds in both the year preceding and the year following, with any pregnancy-associated ED visit having 1.20 (95% CI=1.17, 1.23) times the odds of admission in 2020 as in 2016 and 1.28 (95% CI=1.25, 1.31) times the odds of admission in 2020 as in 2021. The odds of admission steadily increased for each age category up to the age of 39 years, with odds of admission being 1.66 (95% CI=1.62, 1.71) times for women aged 35−39 years as for women aged 20−24 years. We found that pregnancy-associated visits for patients of Black or African race had 0.58 (95% CI=0.57, 0.59) times the odds of admission as those for White individuals, whereas visits for American Indian women had 0.55 (95% CI=0.51, 0.59) times odds of admission as for White patients. Visits for patients of other races did not have odds of admission significantly different from those for White patients (1.05; 95% CI=1.02, 1.08). Only visits for patients of Asian or Pacific Islander race had higher odds of admission than those for White patients (1.65; 95% CI=1.57, 1.74). Pregnancy-associated visits for women of Hispanic origin had higher odds of admission than for women not of Hispanic origin (1.11; 95% CI=1.08, 1.14). Visits for patients from rural counties had the lowest odds of

Table 1. Characteristics of Study Sample, NC DETECT 2016–2021

	All ED visits for WRA		Pregnancy-associated ED visits	
Variables	***n***	**%**	***n***	**%**
Total ED visits	N=6,471,197		*n*=655,476	
Mean age±SD	29.4±8.0		26.6±5.9	
Age, years				
15–19	826,116	12.8%	67,178	10.2%
20–24	1,239,369	19.2%	200,060	30.5%
25–29	1,311,228	20.3%	190,841	29.1%
30–34	1,158,555	17.9%	124,211	18.9%
35–39	1,019,723	15.8%	58,133	8.9%
40–44	916,206	14.2%	15,053	2.3%
Race				
American Indian	75,041	1.4%	7,343	1.3%
Asian or Pacific Islander	42,902	0.8%	7,794	1.4%
Black or African American	2,064,223	38.6%	211,583	37.9%
Other[a]	352,050	6.6%	58,859	10.5%
White	2,672,529	50.0%	258,048	46.2%
Unknown	140,780	2.6%	14,678	2.6%
Ethnicity				
Hispanic origin	315,578	7.2%	59,710	10.7%
Not of Hispanic origin	3,484,359	79.3%	409,843	73.4%
Unknown	593,283	13.5%	88,752	15.9%
County of residence				
Rural	2,430,505	43.9%	271,897	41.5%
Suburban	1,388,604	25.1%	172,318	26.3%
Urban	1,696,224	30.9%	210,998	32.2%
Unknown	1,559	0.1%	263	0.0%
Insurance payer				
Medicaid	1,852,882	33.8%	327,606	50.0%
Non-Medicaid government payer[b]	200,721	5.3%	23,489	3.6%
Other[c]	302,771	3.9%	15,375	2.3%
Private	1,445,821	27.4%	175,172	26.7%
Self-pay	1,411,363	24.6%	88,381	13.5%
Unknown	303,334	4.9%	25,453	3.9%
Disposition				
Admitted	455,265	7.0%	101,534	15.5%
Died	1,776	0.0%	61	0.0%
Discharged	5,571,440	86.1%	510,799	77.9%
Left AMA or without being seen	210,766	3.3%	14,602	2.2%
Observation	2,620	0.0%	259	0.0%
Other	106	0.0%	3	0.0%
Transfer to another hospital[d]	34,055	0.5%	4,850	0.7%
Transfer to other health care[e]	67,930	1.0%	7,008	1.1%
Unknown	127,239	2.0%	16,360	2.5%

Note: Data are presented as counts and percentages. WRA are those aged 15–44 years.
[a]Other race includes patients documented as identifying as more than one race, Hispanic or Latin American, European, or Middle Eastern.
[b]Non-Medicaid government payer includes Medicare.
[c]Other insurance payer includes worker's compensation and no charge.
[d]Transfer to another hospital is considered an admission because it includes patients admitted to a higher level of care.
[e]Transfer to other health care includes transfers and discharges to a skilled nursing facility, intermediate care facility, certified home care, or other types of institution not including a prison or jail.
AMA, against medical advice; ED, emergency department; NC DETECT, North Carolina Disease Event Tracking and Epidemiologic Collection Tool; WRA, women of reproductive age.

Table 2. Proportions of Pregnancy-Associated ED Visits Attributed to Specific Sociodemographic Groups

Characteristic	Proportion of pregnancy-associated ED visits	Estimated proportion[a] of pregnant NC population
Age, years		
15–19	0.10 (0.10, 0.10)	0.06
20–24	0.31 (0.30, 0.31)	0.22
25–29	0.29 (0.29, 0.29)	0.30
30–34	0.19 (0.19, 0.19)	0.27
35–39	0.09 (0.09, 0.09)	0.13
40–44	0.02 (0.02, 0.02)	0.03
Race[b]		
American Indian	0.01 (0.01, 0.01)	0.02
Asian or Pacific Islander	0.01 (0.01, 0.01)	0.05
Black or African American	0.39 (0.39, 0.39)	0.29
Other[c]	0.10	
White	0.48 (0.47, 0.48)	0.64
Ethnicity[b]		
Hispanic origin	0.13 (0.13, 0.13)	0.16
Not of Hispanic origin	0.87 (0.87, 0.87)	0.84
County of residence		
Rural	0.41 (0.41, 0.42)	0.38
Suburban	0.26 (0.26, 0.26)	0.24
Urban	0.32 (0.32, 0.32)	0.38
Insurance payer		
Medicaid	0.52 (0.52, 0.52)	0.55[d]
Non-Medicaid	0.48 (0.48, 0.48)	0.46

Note: Data are presented as proportions (95% CI). Unknown values are not included in the denominator of proportion calculations. One-sample *t*-tests were performed comparing the proportion of pregnancy-associated ED visits with the estimated proportion of the pregnant population in NC. For all comparisons, the *p*-value was <0.0001. Also shown is the proportion of pregnancies attributed to each sociodemographic group in NC, 2016–2021.

[a]Estimated proportion of pregnant NC population calculated using NCHS Bridged Population Data from 2016 to 2020 from the NC State Center for Health Statistics and the Pacific formula developed by the CDC for pregnancy estimation.[14,19,20,33–41]

[b]Owing to missing values >10%, pregnancy-associated ED visit proportions for race and ethnicity do not include 2016 NC DETECT data.

[c]NCHS does not track Other as a race category.

[d]Estimated Medicaid population obtained from reports published by the NCHS.[20,35–38]

CDC, Centers for Disease Control and Prevention; ED, Emergency Department; NC, North Carolina; NC DETECT, North Carolina Disease Event Tracking and Epidemiologic Collection Tool; NCHS, National Center for Health Statistics.

admission than for patients from urban counties (0.71; 95% CI=0.70, 0.72), whereas patients from suburban counties had next lowest odds than those from urban counties (0.87; 95% CI=0.85, 0.89). Non-Medicaid government payer–covered visits had 1.28 (95% CI=1.24, 1.33) times the odds of admission as Medicaid visits, whereas private payer–covered visits had 1.32 (95% CI=1.30, 1.35) times. In contrast, visits covered by self-pay had lower odds of admission than those covered by Medicaid (0.29; 95% CI=0.28, 0.30) (Table 3).

In the sensitivity analysis that limited the observations to only the first ED visit for each patient at each facility, the number of visits included in the pregnancy-associated admission model reduced from 655,476 to 385,858. However, there were no notable differences in the odds of admission from the full model (Appendix Table 4, available online). Separately, we evaluated the odds of admission for all WRA regardless of pregnancy status and performed a subsequent sensitivity analysis. Results for these analyses are found in Appendix Tables 5 and 6 (available online).

DISCUSSION

In our population-based study of virtually all ED visits in NC, 1 of 10 visits for WRA was associated with pregnancy. This reinforces previous findings that ED utilization is common during pregnancy in the U.S.[8,9,11,21,22] Previous studies have reported a wide range of ED utilization for women during pregnancy (between 20% and 84% for at least 1 visit), and the highest rates of ED visits have been consistently seen among women who are non-White, insured by Medicaid, and of younger age.[8,21–25]

It is unclear why the rates of pregnancy-associated ED visits and the rate of admission for pregnancy-associated

Table 3. Sociodemographic Predictors of Admission Among Pregnancy-Associated ED Visits in NC, 2016–2021

Covariates[a]	AOR (95% CI)
Year	
2016	ref
2017	0.84 (0.82, 0.87)
2018	0.92 (0.90, 0.95)
2019	1.05 (1.03, 1.08)
2020	1.20 (1.17, 1.23)
2021	0.94 (0.91, 0.96)
Age	
15–19 years	0.84 (0.81, 0.86)
20–24 years	ref
25–29 years	1.26 (1.23, 1.28)
30–34 years	1.60 (1.57, 1.64)
35–39 years	1.66 (1.62, 1.71)
40–44 years	1.24 (1.18, 1.30)
Race	
American Indian	0.55 (0.51, 0.59)
Asian or Pacific Islander	1.65 (1.57, 1.74)
Black or African American	0.58 (0.57, 0.59)
Other	1.05 (1.02, 1.08)
White	ref
Ethnicity	
Hispanic origin	1.11 (1.08, 1.14)
Not of Hispanic origin	ref
County of residence	
Rural	0.71 (0.70, 0.72)
Suburban	0.87 (0.85, 0.89)
Urban	ref
Insurance payer	
Medicaid	ref
Non-Medicaid government payer[b]	1.28 (1.24, 1.33)
Other[c]	0.96 (0.92, 1.01)
Private	1.32 (1.30, 1.35)
Self-pay	0.29 (0.28, 0.30)

Note: Data are presented as AORs (95% CI). WRA are those aged 15–44 years.
[a]Model is adjusted for visit year, age group, race, ethnicity, type of county of residence, and insurance payer (AUC=0.658).
[b]Non-Medicaid government payer includes Medicare.
[c]Other insurance payer includes visits covered by worker's compensation and visits with no charge. AUC, area under the curve; ED, emergency department; NC, North Carolina; WRA, women of reproductive age.

ED visits are increasing. Although these data do include the early years of the coronavirus disease 2019 (COVID-19) pandemic, the increases are apparent even before 2020. However, the COVID-19 pandemic was associated with a 42% decline in the use of the ED overall during the early weeks of NC's stay-at-home order. This may partially account for an increase in the relative proportion of ED visits that were pregnancy-associated.[26] Perhaps pregnant patients were more likely to seek emergency care than others during the pandemic, indicating a higher need for emergency care during pregnancy when there were barriers to completing in-person prenatal visits. It may also signal that pregnancy complications requiring emergency health care spiked because of COVID-19 infection during pregnancy, which is more severe in pregnant patients than in nonpregnant patients.[27,28] However, the highest proportion of admissions from pregnancy-associated ED visits (19.0%) occurred in 2020 and not in 2021. This may represent inadequate access to prenatal care, an increase in the need for emergency care during pregnancy due to the increasing risk profile of pregnancies in NC and nationally, and/or increases in systemic and interpersonal racism adversely impacting maternal health. More studies are needed to fully explore the cause(s) for this; however, real-time use of surveillance data may be important in monitoring the trend and assessing the potential impact of interventions to address this.[29,30]

Our finding that pregnancy-associated ED visits for women aged between 15 and 19 years were significantly higher than expected supports the results of a study of a mostly rural county in Michigan, which found higher ED utilization for pregnant adolescents aged <20 years.[11] We also found that pregnancy-associated ED visits happened at higher than expected proportions for women aged between 20 and 24 years and lower than expected for those aged 25–44 years. This strengthens the findings from prior studies, which found that younger pregnant patients seek emergency care more often than those in their late 30s and early 40s.[8–10,21]

Vladutiu et al. previously found that pregnant women in NC living in nonrural counties and insured by Medicaid had higher ED utilization rates.[9] Our findings differ slightly; we found that pregnancy-associated ED visits had a higher-than-expected proportion of women from rural and suburban counties, with a significantly lower proportion from urban counties. One major difference between the 2 studies is that the study by Vladutiu used Medicaid-only data from 2008 and 2009, whereas our data are more recent and comprehensive of all payers. Therefore, inconsistencies may be due to differences between the populations or time-varying factors such as access to prenatal care or obstetrical unit closures. These may be particularly relevant for rural-dwelling individuals.

Before adjusting for confounders, we unexpectedly found a significantly lower-than-expected proportion of Medicaid coverage for pregnancy-associated ED visits. The proportion of Medicaid-covered pregnancy-associated ED visits decreased by >11% (from 55.3% in 2016 to 43.9% in 2021). It is not clear from our data why this decrease occurred. However, these changes underscore

the importance of surveilling pregnancy-associated ED visit data so that maternal health public health workers and policymakers can identify needs and interventions to respond to those needs. One potential factor is that in 2021, NC Medicaid was privatized and is now being provided by 5 different commercial payers across the state. Given this recent change, it is possible that some visit insurance information was misclassified as private when in fact it was Medicaid.

The proportion of pregnancy-associated ED visits was higher than expected for women of Black or African American race, confirming results from previous studies.[9,21,22,25] Interestingly, these pregnancy-associated ED visits for women of Black or African American race had only 0.58 (95% CI=0.57, 0.59) odds of admission compared with those for White women. Perhaps this lower rate of admission reflects inadequate access to nonemergent but necessary prenatal care. However, this finding is concerning when interpreted within the well-known context of significantly higher maternal mortality and morbidity for Black or African American women in the U.S.[2–4] This is especially poignant in the light of additional evidence of inequities: that Black women waited 46% longer than White women for pregnancy problems in a national sample of ED wait times in the U.S.[31] The question that naturally follows is whether Black patients are less likely than White patients to be admitted despite similar pregnancy-related concerns owing to interpersonal or systemic racism. This question is deserving of more research and unfortunately cannot be answered using NC DETECT data.

Limitations

Our findings are limited by the following factors. First, NC DETECT is structured by individual visits rather than by patient records. There is no way to link ED visits for the same patient together across separate hospital systems or to distinguish between ED visits that occur during different pregnancies. Consequently, we are unable to calculate the frequency of ED utilization for specific individuals and specific pregnancies. Therefore, the visits are not truly independent observations, and all statistical tests we performed are reliant on a false assumption. However, our results did not change significantly after filtering, to evaluate only the first visit for each unique Internal Tracking identification, which is the identifier that can identify repeat visits at the same facility. It is important to consider the possibility that pregnancy-associated visits being significantly higher than expected may be due to certain individuals making more visits or more individuals making at least 1 visit or some combination. Furthermore, it is unclear from this data set whether this could be related to poor access to care or worsened incidence of chronic conditions. This type of analysis is not able to be done with NC DETECT data. We have shared our findings with regional perinatal stakeholders as part of the NC Provider Support Network with the Maternal Health Innovation Project, the NC Public Leaders Conference, and the NC Obstetrical and Gynecologic Society. The data stimulated discussion about preventive strategies as well as opportunities to dig deeper into individual health system data to better understand questions about repeat visits and reasons for differential admission rates.

Second, the proportion of ED visits related to pregnancy is likely undercounted for several reasons. We defined pregnancy-associated ED visits solely according to associated ICD-10-CM diagnosis codes. Diagnosis code data are not always complete and accurate, and this may be particularly the case among pregnant patients who are seen for reasons unrelated to their pregnancy. Pregnancy may not be disclosed or tested, or the Z33 incidental pregnancy ICD-10-CM code may not be added to the encounter.

Furthermore, this study cannot account for the use of obstetrical triage units that are not ED. It is likely that the true number of ED visits related to pregnancy is undercounted in our data. A better method may be to include only patients with a positive pregnancy test as well as all patients who presented to obstetrical triage units located outside of an ED within a labor and delivery department; however, these data elements are not available in NC DETECT. This makes our findings that ED visits were more likely than expected to be pregnancy-associated in this population even more compelling because we were likely undercounting pregnancy-associated visits. Third, NC DETECT was designed as a population-based surveillance data system that includes limited data elements. Therefore, the covariates that could be included in this study were limited. Fourth, approximately 7.8% of ED visits for WRA were excluded from the analysis because no ICD-10-CM code was provided. Visits missing diagnosis data are more likely to have involved the patient leaving without being seen, but it is unclear whether they would have been more or less likely to be pregnancy-associated.

Finally, although there is limited selection bias in this study, there may be bias in the missingness of race and ethnicity data. There was a large number of missing values for race and ethnicity in 2016 (12.0% and 17.4%, respectively) (Appendix Table 7, available online); therefore, we limited calculations of proportions for race and ethnicity to ED visit data from 2017 to 2021 only. In addition, the data aggregator that compiles data for NC DETECT changed in July 2021. This change required the remapping of local hospital codes to standardized

codes for race, ethnicity, insurance coverage, disposition, and transport mode. Trend changes seen during this period may be attributable to this change and not a true change in the NC population. Race and ethnicity are social constructs, and high-quality, complete data are challenging to obtain for most states in the U.S.[32] For any number of reasons, patients may not feel comfortable self-identifying and may not personally identify as one of the options provided to them, or someone else may choose values on the basis of their perception of the patient. We did not analyze the randomness of missing data for race or ethnicity and chose to include all years in both of our models.

Overall, the results of this study are generalizable to the entire state of NC, with exceptions for military and incarcerated populations. Because our analysis is limited to a single state between 2016 and 2021, extrapolation to years before 2016 and states outside NC is uncertain. Furthermore, NC has not expanded Medicaid under provisions of the Affordable Care Act, so our findings may not generalize well to states that did choose to expand Medicaid.

CONCLUSIONS

Our results are consistent with prior research showing high ED utilization during pregnancy. The proportion of pregnancy-associated ED visits is increasing significantly in NC, given the trends seen during 2016–2021. Furthermore, the percentage of pregnancy-associated ED visits leading to admission appears to have increased between 2016 and 2021, peaking at 19.0% odds of admission in 2020. Taken together, these suggest that the needs for emergency care during pregnancy may be increasing, despite little change in pregnancy rates. When considered together with the ongoing disparities in maternal morbidity and mortality, the disparities in ED utilization as well as admission from the ED by race, ethnicity, and insurance status further suggest that ED utilization may be an indicator of missed opportunities for high-quality prenatal care and a predictor of worse pregnancy outcomes. We believe that there is an untapped opportunity for policymakers and public health professionals in maternal health care to use real-time surveillance data such as NC DETECT to help determine funding and programmatic priorities around prenatal care in specific geographic locations.

ACKNOWLEDGMENTS

The findings and conclusions in this publication are those of the author(s) and do not necessarily represent the views of the North Carolina HHS, Division of Public Health. We acknowledge this sponsor's role in data curation as well as in the final review of this report before submission for publication. North Carolina Translational and Clinical Sciences was not involved in any of the following: analysis or interpretation of data, report writing, nor the decision to submit this report for publication. The UNC Medical Alumni Foundation sponsor was not involved in any of the following: study design; analysis or interpretation of data, report writing, nor the decision to submit this report for publication.

This work was supported by the UNC Medical Alumni Foundation (Chapel Hill, NC), the North Carolina HHS, Division of Public Health (Grant Numbers NU90TP922002 and B0447436), and the NIH (Grant Number UL1TR002489). The North Carolina Disease Event Tracking and Epidemiologic Collection Tool is an advanced, statewide public health surveillance system. North Carolina Disease Event Tracking and Epidemiologic Collection Tool is supported by the North Carolina Division of Public Health through a federal Public Health Emergency Preparedness Grant and is managed through a collaboration between the North Carolina Division of Public Health and the University of North Carolina at Chapel Hill Department of Emergency Medicine's Carolina Center for Health Informatics. For assistance in designing our initial data analysis methodology, we acknowledge the North Carolina Translational and Clinical Sciences Institute, which is supported by the National Center for Advancing Translational Sciences, NIH through Grant Award Number UL1TR002489. We acknowledge financial support from the UNC Medical Alumni Foundation through the Carolina Medical Student Research Program, through which the primary investigator was able to begin this research project.

Declaration of interest: None.

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SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.focus.2023.100142.

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