



Emergency Care Utilization Among Pregnant Medicaid Recipients in North Carolina: An Analysis Using Linked Claims and Birth Records

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Abstract

Objectives To estimate the rate of pregnancy-associated emergency care visits and identify maternal and pregnancy characteristics associated with high utilization of emergency care among pregnant Medicaid recipients in North Carolina. **Methods** A retrospective cohort study using linked Medicaid hospital claims and birth records of 107,207 pregnant Medicaid recipients who delivered a live-born infant in North Carolina between January 1, 2008 and December 31, 2009. Rates were estimated per 1000 member months of Medicaid coverage. High utilization was defined as ≥ 4 visits. Emergency care visits included encounters in the emergency department or obstetric triage unit during pregnancy that did not result in hospital admission. **Results** During the study period, 57.5% of pregnant Medicaid recipients sought emergency care at least once during pregnancy. There were 171,909 emergency care visits with an overall rate of 202.3 visits per 1000 member months. Among the subset of pregnant women with Medicaid coverage for the majority of their pregnancy ($n = 75,157$), 18.1% were high utilizers. High emergency care utilization was associated with young age, black race, lower education, tobacco use, late preterm delivery, multifetal gestation, and having ≥ 1 comorbidity. Threatened labor and abdominal pain were the leading indications for visits. **Conclusion** Utilization of hospital-based emergency care services was common in this cohort of pregnant Medicaid recipients. Additional research is needed to assess the drivers for accessing care through the emergency department, and to examine differences in pregnancy outcomes and health care costs between high and low utilizers.

Keywords Emergency department · Medicaid · North Carolina · Pregnancy

Significance

What is already known on this subject? Emergency department visits occur frequently among Medicaid recipients and problems related to pregnancy are leading

indications for evaluation. However, little is known about the patterns of emergency care utilization during pregnancy in a Medicaid population, including the frequency, timing and indication of visits. *What this study adds?* This study utilized linked statewide databases with detailed information on pregnancy-associated emergency care visits to emergency departments and obstetric triage units among pregnant Medicaid recipients. Emergency care visits occurred frequently, particularly later in pregnancy, and several factors were associated with high utilization, thus suggesting the need for interventions to improve access and continuity of care during pregnancy.

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Introduction

Emergency department (ED) visits are an important entry point for access to health care and the number of annual visits continues to rise. In 2014, an estimated 137 million ED visits occurred across the United States; women

accounted for more than half of these visits (Moore et al. 2017). Pregnancy is a critical time for women to receive health care services and problems related to pregnancy are a leading indication for evaluation in EDs. In 2014, problems of pregnancy and the postpartum period were the 7th leading indication for ED visits among women aged 15–64 years (Rui and Kang 2014). Medicaid is the most frequent payer for ED visits during pregnancy. A recent report from the Healthcare Cost and Utilization Project (HCUP) estimated that 58.1% of all ED visits for maternal/neonatal diagnoses were billed to Medicaid (Moore et al. 2017).

Despite the burden of use, little is known about patterns of emergency care utilization among pregnant women, including the frequency, indication, and timing of visits. Previous studies have assessed pregnancy-associated ED use in the US, but they have been limited by small sample sizes (Kilfoyle et al. 2017; Malik et al. 2017; Sharp et al. 2016) and were focused mostly on trauma-related visits (Nannini et al. 2011; Weiss et al. 2008) and problems during early pregnancy (Sharp et al. 2016; Wittels et al. 2008). A more recent nationwide study focused exclusively on commercially insured women and lacked information on important maternal and pregnancy characteristics (e.g., race, ethnicity, education, gestational age at time of visit) (Cunningham et al. 2017). Additionally, these studies likely did not include emergency care visits in an obstetric unit, thus underestimating emergency care utilization during pregnancy. Pregnant women at later gestational ages often bypass the ED and are treated directly in an obstetric triage unit. There is a paucity of published literature on the epidemiology of any emergency care utilization throughout pregnancy, including high utilization, especially in a pregnant Medicaid population. Pregnant Medicaid recipients may have high emergency care use partly due to unmet health needs and limited access to care in appropriate settings. The use of linked statewide databases with detailed information on pregnancies and visit characteristics for all pregnancy-associated emergency care visits billed to Medicaid, including those in obstetric triage units, can address these prior limitations.

In North Carolina, more than half of all births are covered by Medicaid each year (North Carolina State Center for Health Statistics 2017). A better understanding of the frequency and circumstances surrounding ED use during pregnancy and the factors associated with high ED utilization in the pregnant Medicaid population can identify opportunities to improve access to and quality of care for these women. To address gaps in the literature and to inform actionable interventions, our objectives were to estimate the rate of pregnancy-associated emergency care visits and to identify maternal and pregnancy

characteristics associated with high utilization of emergency care among pregnant Medicaid recipients in North Carolina. We also sought to describe the indication and timing of these visits.

Methods

Data Sources

This is a retrospective cohort study of pregnant Medicaid recipients in North Carolina. Data were obtained from a linked database of North Carolina hospital Medicaid claims and live birth records. Medicaid claims were retrospectively available from the Community Care of North Carolina, Pregnancy Medical Home (PMH) program (<https://www.communitycarenc.org/population-management/pregnancy-home/>), launched in 2011 and designed to improve access to care and perinatal outcomes, while also reducing costs in the pregnant Medicaid population. Live birth records were provided by the North Carolina State Center for Health Statistics. To identify pregnant Medicaid recipients who delivered a live-born infant in North Carolina between January 1, 2008 and December 31, 2009 (prior to implementation of the PMH program), infant birth certificates were deterministically linked to the mother's Medicaid claims using a multiple-step strategy with the following match fields: mother's first and last name, mother's date of birth, date of delivery, and county of occurrence. Records were matched sequentially in a series of steps first requiring an exact match on all identifiers and subsequently using a combination of deterministic and probabilistic match criteria for each successive round, such as requiring an exact match for some identifiers (e.g., mother's date of birth) while allowing for close matches on others (e.g., nicknames). The maternal record linkage yielded a match rate of 95%.

From this maternal record linkage, we identified 135,274 live-born infants among Medicaid recipients who delivered in North Carolina between January 1, 2008 and December 31, 2009. Miscarriages were not included because they are not reported in North Carolina vital records. We excluded births that were covered by emergency Medicaid insurance as it only covers the delivery admission ($n=27,053$). Women who qualify for emergency Medicaid for the delivery hospitalization do not have complete Medicaid coverage for outpatient services, thus ED utilization by these women would not be captured in Medicaid claims. We also excluded those missing data for gestational age ($n=23$). Since multiple gestations were included, the remaining 108,198 births in the sample represented 107,262 unique pregnancies, which we identified using a combination of mother's Medicaid ID and delivery date. We further excluded pregnancies with missing or incongruent data on months enrolled in Medicaid ($n=55$). Our final sample included 107,207 pregnancies.

Measures

Emergency Care Visit

An emergency care visit was defined as an encounter in the ED (revenue codes 450, 451, 456, 459) or obstetric triage unit (revenue codes 720 and 729) that did not result in a hospital admission. These place of service codes were selected because many obstetric triage units in North Carolina hospitals serve as the “emergency care” evaluation location for women who are pregnant. We used the clinical estimate of gestational age and the delivery date, as reported in the vital records, to estimate when the visits occurred. Emergency care visits were counted beginning in February 23, 2007 for women who delivered a live-born infant in January 2008.

Medicaid Member Months

Individuals with preexisting traditional Medicaid were documented as having insurance coverage for the entire duration of their pregnancy. For women enrolled in Medicaid for Pregnant Women (defined as Medicaid coverage for eligible pregnant women only for services related to pregnancy from prenatal care through 60 days after delivery), we identified the month of enrollment and calculated the total number of months enrolled in Medicaid (“Medicaid member months”) per pregnancy as the difference between the month of enrollment and the month of delivery.

Maternal and Pregnancy Characteristics

Sociodemographic and pregnancy characteristics included age, race and Hispanic ethnicity, education, marital status, area of residence (categorized as metropolitan, micropolitan, and rural according to the US Census Bureau’s core based Statistical Areas or CBSA) (US Census Bureau 2018), type of Medicaid, prenatal tobacco and alcohol use, multifetal gestation, parity (defined as the total number of prior live births), trimester of prenatal care initiation, and selected medical comorbidities. Data were obtained from live birth records, with the exception of Medicaid type and comorbidities which were obtained from the Medicaid claims. We used the secondary or higher diagnosis codes (up to nine reported) to identify the presence of 11 comorbid conditions that were of interest for this analysis.

Visit Characteristics

Characteristics of the visits included gestational age at the time of visit; day, month, and time of visit; population density (defined by CBSA status); obstetric provider density

(defined as the number of licensed obstetricians, certified nurse midwives, or family medicine physicians practicing obstetrics within each provider county per 10000 women, aged 15 to 44 years, residing in each county), and indication for the visit (defined by up to nine diagnosis codes). County-level data on the number of licensed obstetric providers were obtained from the North Carolina Health Professions Data System. Obstetric provider density was grouped into tertiles for reporting purposes. Data for all other visit characteristics were obtained from the Medicaid claims.

Diagnosis and procedure codes were ranked using the single-level Clinical Classifications Software (CCS) for the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM), developed as part of the HCUP (Healthcare Cost and Utilization Project, 2018). For this analysis, the primary and secondary diagnosis codes were abstracted for each emergency care visit. If the primary diagnosis code was nonspecific (e.g., “other condition antepartum”, “pregnancy complication not elsewhere classifiable”, “pregnancy classification not otherwise specified”), then we relied on the secondary diagnosis code for that visit. Nearly 32% of primary diagnoses were nonspecific and thus were replaced with the secondary codes. Diagnosis codes for this analysis are provided in Appendix 1.

Statistical Analysis

We conducted descriptive analyses to examine socio-demographic and pregnancy characteristics of pregnant Medicaid recipients. Rates of emergency care visits were estimated for selected maternal characteristics and defined as the number of visits divided by the number of Medicaid member months to account for the variability in Medicaid coverage across women. We conducted additional analyses to examine visit characteristics and reported the top ten indications for visits.

To assess maternal and pregnancy characteristics associated with high utilization of emergency care we restricted the analysis to 75,157 pregnant Medicaid recipients who were insured by Medicaid for the majority of their pregnancy (defined as 2 months or less difference between the total months of gestation and the total months of Medicaid coverage during pregnancy). The threshold for high (≥ 4 visits) and low (< 4 visits) utilization is commonly used in prior research of adult and pediatric populations (LaCalle and Rabin 2010) and is equivalent to the 90th percentile of number of visits in our study population. Logistic regression models were used to estimate odds ratios for the association between selected characteristics and high (vs. low) utilization of emergency care. Stepwise regression with backward elimination was performed to select an adjusted model. Main effects were retained in the model if p-values were

< 0.05. All analyses were performed with SAS version 9.2 software (SAS Institute, Cary, NC). This study was approved by the Institutional Review Board (IRB) of the University of North Carolina at Chapel Hill (IRB #12-2453) and has been performed in accordance with the ethical standards established by the World Medical Association in the Declaration of Helsinki.

Results

Study population

A total of 107,207 pregnancies met the eligibility criteria in 2008–2009. High proportions of these pregnant women were aged 24 years or younger (60.5%), non-Hispanic white (50.0%), high school graduates (66.1%), married (69.7%), lived in metropolitan areas (65.0%), and were insured by Medicaid for Pregnant Women (67.4%) (Table 1). Tobacco and alcohol use were reported in 19.7% and 0.5% of pregnancies, respectively. According to birth certificate data, a high percentage (77.0%) had prenatal care in the first trimester. Claims data indicated that more than one-third of the women had a history of mental illness. More than half of women had at least one of the selected comorbidities beyond the primary diagnosis at the time of their emergency care visit, including mental illness.

Maternal Characteristics and Visit Rates

During the study period, 61,662 (57.5%) of the 107,207 pregnant Medicaid recipients sought care in an ED or obstetric triage unit without being admitted at least once during pregnancy (median = 1 visit; range = 0 to 65 visits per woman) with an overall rate of 202.3 visits per 1000 member months (Table 1). Pregnant women with the highest rates of emergency care visits had a multifetal gestation (297.6 per 1000), two or more comorbidities (256.8 per 1000), less than a high school education (239.1 per 1000), used tobacco (238.5 per 1000) or alcohol (236.4 per 1000) during pregnancy, were non-Hispanic black (221.8 per 1000), 20–24 years old (219.4 per 1000), and married (211.6 per 1000). Visit rates were higher among women living in micro and metropolitan areas (205.3 and 204.3 per 1000, respectively) than among those living in rural areas (179.3 per 1000).

Characteristics of Emergency Care Visits

Of the 171,909 emergency care visits, 99,843 (58.1%) occurred in an ED and 72,066 (41.9%) were in obstetric triage units. Approximately 28% of all visits occurred during the first trimester, 28% in the second trimester, and 44% in the third trimester (Table 2). Peak visit time was between

12 pm and 8 pm (46.7%). High proportions of visits occurred in counties in metropolitan areas and those with an obstetric provider density at or above the 25th percentile. Visits were distributed equally across days of the week and months of the year (data not shown).

The leading indications for emergency care visits are described in Table 3. Threatened labor and abdominal pain contributed to a quarter of all visits (almost 40% of visits in the third trimester), followed by genitourinary tract infection, vaginal bleeding, and nausea or vomiting. After stratification by trimester of visit, bleeding, nausea or vomiting, abdominal pain, and genitourinary tract infection remained in the top five indications for visits across the first and second trimesters.

Maternal and Pregnancy Characteristics Associated with High Utilization of Emergency Care

Among the 75,157 pregnant women who were insured by Medicaid for the majority of their pregnancy, 13,573 women (18.1%) had ≥ 4 emergency care visits during pregnancy (“high utilizers”). These high utilizers, while only 18% of the population, accounted for 57% of the emergency care visits. Characteristics of these women are presented in Appendix 2. In adjusted models, socio-demographic and pregnancy characteristics associated with high utilization included young age, black race, lower education, prenatal tobacco use, late preterm delivery at 33–36 weeks, multifetal gestation, and having at least one comorbidity (Fig. 1). Older age (≥ 35 years), Hispanic ethnicity, unmarried status, rural residence, and late or no prenatal care were associated with lower odds of high emergency care utilization. Coded indications for emergency care were similar for high and low utilizers.

Discussion

In this population-based study of pregnant Medicaid recipients in North Carolina, we found that more than half of women who had a live-born infant during the study period had an emergency care visit at least once during pregnancy and a high proportion of these visits occurred later in pregnancy. Threatened labor and abdominal pain were the leading indications for visits later in pregnancy while bleeding and nausea or vomiting were most common in the first trimester. Additionally, almost one-fifth of the population was characterized as a high utilizer (≥ 4 visits). These women were more likely to deliver prematurely and have multiple comorbidities as compared to women who utilized emergency care less often.

Our findings are specific to the Medicaid population, however, previous studies have estimated the rate of pregnancy-associated emergency care among commercially

Table 1 Characteristics of pregnant medicaid recipients, by rate of emergency care visits, North Carolina, 2007–2009

Characteristics	Total pregnancies		Emergency care visits ^a		
	N	%	No. of visits	Member months	Rate ^b
Overall	107,207		171,909	849,755	202.3
Age, years					
≤ 19	22,780	21.3	39,142	187,671	208.6
20–24	41,989	39.2	73,967	337,198	219.4
25–29	24,832	23.2	37,488	193,892	193.3
30–34	11,630	10.9	14,780	87,740	168.4
≥ 35	5976	5.6	6532	43,254	151.0
Race and Hispanic ethnicity					
Non-Hispanic white	46,625	50.0	75,526	372,619	202.7
Non-Hispanic black	41,044	44.1	73,941	333,402	221.8
Non-Hispanic other	3048	3.3	4,176	24,021	173.8
Hispanic	2452	2.6	2,912	18,090	161.0
Missing	14,038		15,354	101,263	
Education					
Less than high school	29,478	27.6	57,907	242,219	239.1
Completed high school	44,888	42.0	72,797	358,737	202.9
Some college	25,819	24.1	35,250	199,513	176.7
College graduate	6806	6.4	5,569	47,739	116.7
Missing	216		386	1547	
Marital status					
Married	74,748	69.7	127,633	603,117	211.6
Not married	32,454	30.3	44,264	246,597	179.5
Missing	5		12	41	
Area of residence ^c					
Metropolitan	69,727	65.0	111,403	545,185	204.3
Micropolitan	27,861	26.0	46,556	226,772	205.3
Rural	9619	9.0	13,950	77,798	179.3
Prenatal tobacco use					
Yes	21,076	19.7	40,680	170,559	238.5
No	86,008	80.3	130,908	678,286	193.0
Missing	123		321	910	
Prenatal alcohol use					
Yes	549	0.5	936	3,959	236.4
No	106,528	99.5	170,268	844,822	202.0
Missing	130		345	974	
Type of medicaid					
Medicaid for pregnant women	72,303	67.4	99,662	548,953	181.5
Preexisting traditional Medicaid	34,904	32.6	72,247	300,802	240.2
Parity (No. of prior live births)					
0	46,333	43.3	70,213	361,451	194.3
1	30,854	28.8	50,777	248,818	204.1
2	17,588	16.4	29,498	141,189	208.9
3+	12,403	11.6	21,295	98,066	217.2
Missing	29		126	231	
Multifetal gestation					
Yes	1737	1.6	3613	12,140	297.6
No	105,470	98.4	168,296	837,615	200.9
Trimester prenatal care began					
1st trimester	81,503	77.0	136,902	662,813	206.5

Table 1 (continued)

Characteristics	Total pregnancies		Emergency care visits ^a		
	N	%	No. of visits	Member months	Rate ^b
2nd trimester	20,384	19.3	28,380	153,643	184.7
3rd trimester	2991	2.8	3717	18,565	200.2
No prenatal care	1007	1.0	899	5,101	176.2
Missing	1322		2011	9633	
Medical comorbidities ^d					
Diabetes	6270	5.9	11,618	49,032	236.9
Chronic hypertension	3356	3.1	7504	26,535	282.8
Gestational hypertension	4444	4.2	8135	35,329	230.3
Preeclampsia	5203	4.9	9234	39,539	233.5
Cardiac disease	708	0.7	1573	5545	283.7
Lung disease	3,471	3.2	8790	28,563	307.7
Hemoglobinopathy	1,410	1.3	2642	11,295	233.9
Mental illness	41,251	38.5	66,259	336,703	196.8
Gastrointestinal disease	157	0.2	388	1245	311.6
Renal disease	307	0.3	685	2468	277.6
Connective tissue disease	168	0.2	449	1,344	334.1
Number of medical comorbidities ^e					
None	49,833	46.5	74,293	387,683	191.6
One	48,984	45.7	80,249	394,440	203.5
Two or more	8390	7.8	17,367	67,632	256.8

^aEmergency care visits defined according to revenue codes: 450, 451, 456, 459, 720, 729

^bRate per 1000 member months

^cCategorized according to the US Census Bureau's core based statistical areas

^dCategories are not mutually exclusive

^eComorbidities include the 11 conditions mentioned above

insured women with estimates of having at least one ED visit during pregnancy ranging from 20% among a national sample of commercially insured pregnant women (Cunningham et al. 2017) to 49% among publicly insured patients in a university hospital (Magriples et al. 2008). Our finding that more than half of pregnant Medicaid recipients received emergency care is higher than these estimates of commercially insured women, which is consistent with a recent report from HCUP suggesting that Medicaid is the most frequent payer for ED visits during pregnancy (Moore et al. 2017).

In our study, more than one-quarter of emergency care visits occurred during the first trimester and the leading indications for these visits were common early pregnancy concerns. However, this cohort is not fully reflective of first trimester emergency care since it is limited to pregnancies that resulted in a live birth and thus may underestimate the frequency of first-trimester visits. Although it is important not to deter pregnant women from seeking emergency services for acute problems (e.g., ectopic pregnancy, heavy vaginal bleeding), it is possible that some of these first-trimester visits may have been for non-urgent conditions and could have been handled in

an office setting by a nurse or physician. Our data also indicate that most visits occurred in the afternoon and early evening when office visits may not be available. Overall, these findings can help to guide care and policy for the maternal and child health population. Specifically, they identify the need for improving access to care, particularly at the onset of pregnancy when women may not have a primary obstetric care provider. These findings also inform efforts to improve appropriate use of emergency care services, such as educating women about available services and how best to use them.

We identified variations in emergency care visit rates by selected maternal characteristics and several of these characteristics were associated with high utilization of emergency care (≥ 4 visits) during pregnancy, including multifetal gestation, having at least one comorbidity, young age, black race, lower education, and prenatal tobacco use. High utilizers were also more likely to deliver an infant between 33 and 36 weeks. Two recent studies found several sociodemographic factors that were similarly associated with ED use during pregnancy, including age (Kilfoyle et al. 2017; Malik et al. 2017), race (Malik et al. 2017), education (Kilfoyle et al. 2017),

Table 2 Characteristics of emergency care visits among pregnant medicaid recipients in North Carolina (N = 171,909 visits), 2007–2009

Visit characteristics	Total	
	N	%
Overall	171,909	
Gestational age at visit		
1st trimester	48,249	28.1
2nd trimester	48,460	28.2
3rd trimester	75,200	43.7
Time of visit		
Midnight–8am	24,283	14.1
8am–12 noon	31,983	18.6
12 noon–4 pm	39,655	23.1
4 pm–8 pm	40,479	23.6
8 pm–midnight	35,509	20.7
Population density ^b		
Metropolitan	115,401	67.3
Micropolitan	45,263	26.4
Rural	10,709	6.3
Missing	536	
Obstetric provider density ^c		
< 25%	7511	4.4
25–75%	92,137	53.8
> 75%	71,725	41.9
Missing	536	

^aEmergency care visits defined according to revenue codes: 450, 451, 456, 459, 720, 729

^bPopulation density defined by provider county according to the US Census Bureau’s core based statistical areas

^cObstetric provider density defined as the number of licensed obstetricians, certified nurse midwives, or family medicine physicians practicing obstetrics within each provider county per 10,000 women, aged 15 to 44 years, residing in each county and grouped into tertiles for reporting purposes

Table 3 Ten leading indications for emergency care visits, overall and by trimester of visit, among pregnant medicaid recipients in North Carolina (n = 171,909 visits), 2007–2009

Total (N = 171,909)	%	First trimester (n = 48,249)	%	Second trimester (n = 48,460)	%	Third trimester (n = 75,200)	%
Threatened labor	13.5	Bleeding	16.2	Abdominal pain	14.8	Threatened labor	28.4
Abdominal pain	11.7	Nausea/vomiting	13.4	Genitourinary infection	10.9	Abdominal pain	9.5
Genitourinary infection	7.8	Abdominal pain	12.1	Bleeding	7.2	Supervision of pregnancy	6.5
Bleeding	7.5	Genitourinary infection	12.0	Injury	6.8	Decreased fetal movement	3.6
Nausea/vomiting	6.5	Genital tract condition	6.0	Nausea/vomiting	6.1	Musculoskeletal	3.5
Injury	4.8	Injury	5.9	Respiratory infection	5.6	Hypertension	3.3
Genital tract condition	4.3	Respiratory infection	4.6	Genital tract condition	5.0	Genitourinary infection	3.1
Respiratory infection	3.9	GI-noninfectious	2.8	Musculoskeletal	4.0	Genital tract condition	2.8
Supervision of pregnancy	3.6	Headache	2.5	Threatened labor	3.6	Injury	2.8
Musculoskeletal	3.3	Musculoskeletal	2.4	Respiratory-noninfectious	3.4	Pregnancy complications (NEC)	2.7

GI gastrointestinal, NEC necrotizing enterocolitis

and smoking (Malik et al. 2017), however, for one study these factors only pertained to non-urgent ED use (Kilfoyle et al. 2017) and neither study assessed frequent utilization. Our study design limits us from knowing

exactly why women with selected characteristics had lower (or higher) odds of high emergency care utilization and we can only speculate about possible explanations. For example, unmarried women may be less likely to

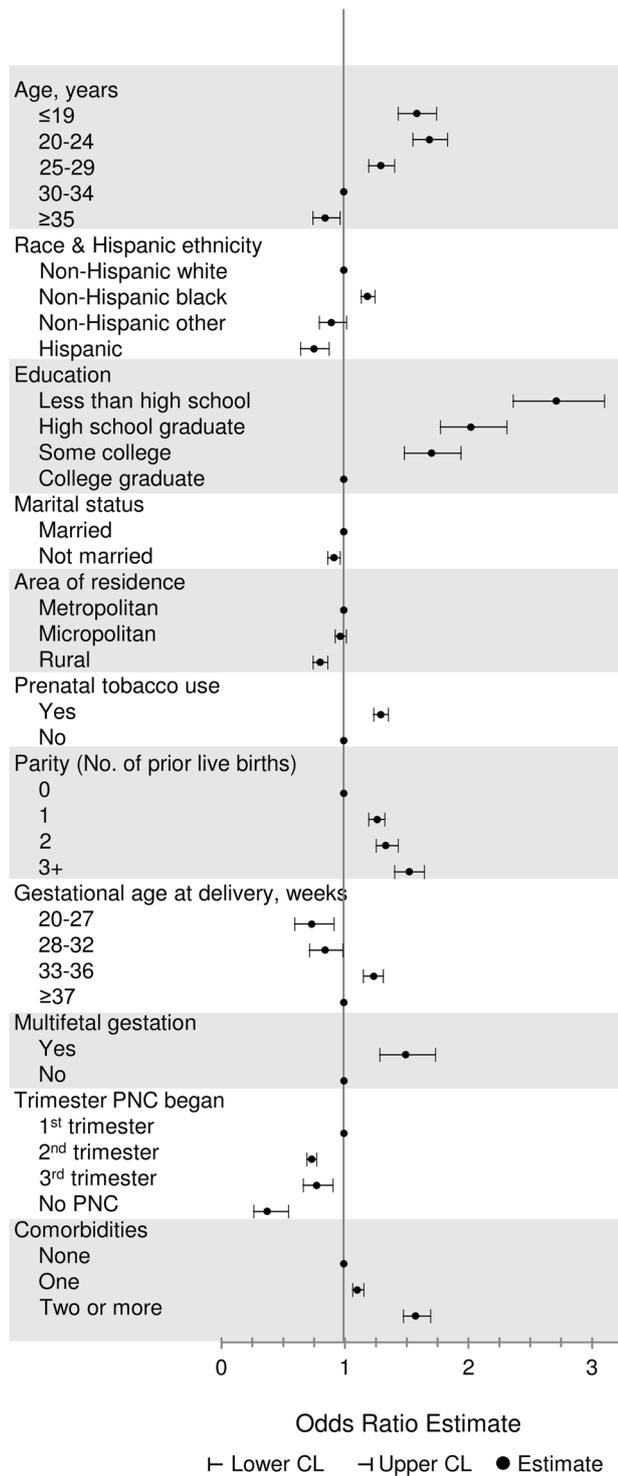


Fig. 1 Adjusted odds ratios for the association between maternal and pregnancy characteristics and high utilization of emergency care among pregnant Medicaid recipients (N = 75,157). These characteristics were identified from a multivariable analysis and variables were selected in the model if $P < 0.05$, while adjusting for all other variables. P -values were estimated from a group test of all coefficients simultaneously and are presented at the referent level for the variable. *PNC* prenatal care, *CL* confidence limit

seek care during pregnancy (Feijen-de Jong et al. 2012). Those with late or no prenatal care may be less likely to seek care, in general, and are not necessarily using the ED for regular prenatal care. Additionally, women in rural areas may have limited access to health care, including emergency care, due to geographic barriers and physician shortages (American College of Obstetricians and Gynecologists 2014). Identifying these characteristics of high utilizers of emergency care is useful for targeting future interventions toward women with these characteristics, such as programs focused on improving care management. More research is needed to better understand the drivers for accessing care and how they differ by maternal characteristics.

Our study expands on previous literature by estimating the rate of emergency care visits throughout the duration of pregnancy and identifying factors associated with high emergency care utilization in a state that has a relatively high proportion of births covered by Medicaid. The strengths of this study include the large cohort of pregnant Medicaid recipients and the use of maternal record linkage to ascertain pregnancy-associated emergency care visits over a multi-year study period. The use of claims data allowed for the inclusion of both ED and obstetric triage visits and provided detailed information on visit characteristics, including the frequency, indication, and timing of visits. It also provided valuable information on medical comorbidities.

This description, while population based, is limited to Medicaid and does not provide informative data on the uninsured and commercially insured populations. Without these comparative data, we are unable to assess differences in the frequency or indication of visits by payer. We were also unable to include miscarriages, thus early pregnancy visits are not fully described in this study. In addition, the data were reported in 2007–2009 and may not reflect current patterns of ED use in the pregnant Medicaid population in North Carolina. However, these data provide valuable information on emergency care utilization prior to implementation of the PMH program and will be used in future PMH evaluation efforts. These data also pre-date the Affordable Care Act, however, North Carolina is not a Medicaid expansion state. We used the clinical estimate of gestational age to determine whether an emergency care visit occurred during pregnancy, but these estimates are prone to error in vital records (Martin 2007) and may result in misclassification of the trimester in which a visit occurred. Medicaid claims rely on clinical coding that may be subject to inconsistency due to missed diagnoses, different coding patterns, and inaccurate coding. The frequency of selected indications for visits and accompanying comorbidities may be over- or underestimated due to this potential for misclassification. We also lacked information on patient acuity and could not determine the urgency of the visits.

Conclusion

Emergency care utilization occurs frequently among pregnant Medicaid recipients and there are several factors associated with high utilization in this population. Health care providers should use this information to target resources toward interventions to improve access and continuity of care during pregnancy and to reduce non-urgent and frequent ED use. In particular, programs should focus on improving care management for high utilizers and helping them to navigate and access the most risk-appropriate source of care, which may end up being the ED. Additional research is needed to assess the appropriateness of visits, explore drivers for accessing emergency care, and to assess differences in pregnancy outcomes and health care costs between high and low utilizers in this Medicaid population.

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Compliance with Ethical Standards

Conflict of interest The authors report no conflicts of interest.

Appendix 1

See Table 4.

Table 4 Diagnosis categories according to the single-level clinical classifications software and additional diagnosis codes

Diagnosis categories	Single-level clinical classifications software category ^a	Additional diagnosis codes
1. Infection (general)	1–4, 7, 8, 10, 246–248	64730–64734, 64740–64744, 64750–64754, 64760–64764, 64780–64784, 64790–64794, 65930, 65931, 65933, 67330–67334
2. Gastrointestinal infection	6, 135	
3. Genitourinary infection	159	64650–64654, 64660–64664
4. Respiratory infection	122–126	
5. Pelvic (puerperal) infection		67000, 67002, 67004, 67010, 67012, 67014, 67020, 67022, 67024, 67080, 67082, 67084
6. Eye or ear infection	90, 92	
7. Sexually transmitted infection (including HIV)	5, 9	64700–64704, 64710–64714, 64720–64724
8. Neoplasm	11–47	
9. Endocrine disorders	48, 51–58	64810–64814, 64910–64914
10. Diabetes	49, 50, 186	
11. Blood disorders	59–64	64820–64824, 64930–64934
12. Neurological disorders	76–83, 85, 93, 95, 109–113	450, 64640–64644, 64940–64944
13. Headache	84	
14. Sensory (eye, ear, sense)	86–89, 91, 94	
15. Cardiac or cardiovascular (non-hypertension)	96, 97, 100–108, 114–119, 121, 245, 249	64850–64854, 64860–64864, 66920–66924, 67030, 67032, 67034, 67100–67104, 67110, 67111, 67112–67114, 67120–67124, 67130, 67131, 67133, 67140, 67142, 67144, 67150–67154, 67180–67184, 67190–67194, 67320–67324, 67380–67384, 67400–67404, 67450–67454
16. Hypertension related	98, 99, 183	
17. Respiratory (non-infectious)	127–134	
18. Dental	136	
19. Gastrointestinal (non-infectious)	120, 137–155	64670, 64671, 64673, 64920–64924
20. Nausea, vomiting, hyperemesis gravidarum	250	64300, 64301, 64303, 64310, 64311, 64313, 64320, 64321, 64323, 64380, 64381, 64383, 64390, 64391, 64393
21. Abdominal pain	251	
22. Urinary	156–158, 160–163	589, 599, 64620–64624
23. Genital tract condition (non-infectious)	164–166, 168–175	65470–65474, 65480–65484, 65490–65494
24. Contraception	176	
25. Abortion	177–179	632, 64630, 64631, 64633, V232

Table 4 (continued)

Diagnosis categories	Single-level clinical classifications software category ^a	Additional diagnosis codes
26. Abnormal pregnancy (ectopic, molar)	180	630, 631, 6310, 6318, V2342
27. Bleeding	182	64950, 64951, 64953
28. Threatened labor	184	6440, V2341
29. Miscellaneous	255, 257, 259	65940, 65941, 65943, 65950, 65951, 65953, 65960, 65961, 65963, E0008, V233, V2349, V235
30. Skin	197–200	
31. Musculoskeletal	201, 203–209, 212, 252, 254	64610–64614, 64870–64874
32. Rheumatologic conditions or connective tissue disease	202, 210, 211	
33. Fetal condition	213–224	64600, 64601, 64603, 64960–64964, V2387, 65500, 65501, 65503, 65510, 65511, 65513, 65520, 65521, 65523, 65530, 65531, 65533, 65540, 65541, 65543, 65560, 65561, 65563, 65580, 65581, 65583, 65590, 65591, 65593, 65600, 65601, 65603, 65610, 65611, 65613, 65620, 65621, 65623, 65640, 65641, 65643, 65650, 65651, 65653, 65660, 65661, 65663, 65680, 65681, 65683, 65690, 65691, 65693, 65970, 65971, 65973, 67800, 67801, 67803, 67910–67914
34. Injury or trauma	225–240, 244, 2601–2612	
35. Poison or allergy	241–243, 253, 2613–2617	
36. Mental health	650–659, 662, 6631, 670	64840–64844, V701, V702, V7109
37. Substance	660, 661, 6632	3051, 64900–64904, V1582
38. Decreased fetal movement		65570, 65571, 65573
39. Pregnancy complications (necrotizing enterocolitis) or other complications of the puerperium		64680–64684, 64690, 64691, 64693, 64890, 64891–64894, 65980, 65981, 65983, 65990, 65991, 65993, 67480, 67482, 67484, 67490, 67492, 67494
40. Multifetal gestation		65100, 65101, 65110, 65111, 65120, 65121, 65170, 65171, 65173, 65180, 65181, 65190, 65191, 65103, 65113, 65123, 65130, 65131, 65133, 65140, 65141, 65143, 65150, 65151, 65153, 65160, 65161, 65163, 65183, 65193
41. Problems of pregnancy (uterus, placenta, amniotic fluid)	191	6570, 65400–65404, 65410–65414, 65430–65434, 65440–65444, 65670, 65671, 65673, 67440, 67442, 67444
42. Cervix		64970, 64971, 64973, 65450, 65451–65454, 65460–65464
43. Labor and delivery or pregnancy complication	188, 190, 192–194	65900, 65901, 65903, 65910, 65911, 65913, 65920, 65921, 65923, 66500, 66501, 66503, 66510–66512, 66514, 66520, 66522, 66524, 66530, 66531, 66534, 66540, 66541, 66544, 66550, 66551, 66554, 66560, 66561, 66564, 66570–66572, 66574, 66580–66584, 66590–66594, 66600, 66602, 66604, 66610, 66612, 66614, 66620, 66622, 66624, 66630, 66632, 66634, 66700, 66702, 66704, 66710, 66712, 66714, 66800–66804, 66810–66814, 66820–66824, 66880–66884, 66890–66894, 66900–66904, 66910–66914, 66930, 66932, 66934, 66940–66944, 66960, 66961, 66970, 66971, 66980–66984, 66990–66994, 67200, 67202, 67204, 67300–67304, 67310–67314, 67410, 67412, 67414, 67420, 67422, 67424, 67430, 67432, 67434, 677, 67900–67904
44. Breast	167	67500–67504, 67510–67514, 67520–67524, 67580–67584, 67590–67594, 67600–67604, 67610–67614, 67620–67624, 67630–67634, 67640–67644, 67650–67654, 67660–67664, 67680–67684, 67690–67694
45. Post-term pregnancy	185	
46. Malpresentation	187	
47. Prior cesarean section	189	
48. Normal labor and delivery	650	64981, 64982, V270
49. Medical exam or evaluation	256, 258	
50. Supervision of pregnancy		V220, V221, V237, V2381–V2384, V2389, V239, V240, V242
51. Pregnant state/exam		V222, V7242

^aSingle-level Clinical Classifications Software (CCS) for the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM), developed as part of the Healthcare Cost and Utilization Project, Agency for Healthcare Research and Quality: <https://www.hcup-us.ahrq.gov/toolsoftware/ccs/AppendixASingleDX.txt>

Appendix 2

See Table 5.

Table 5 Characteristics of pregnant medicaid recipients, by high vs. low utilization of emergency care, North Carolina (n=75,157 women), 2007–2009

	< 4 visits		≥ 4 visits	
	n	%	n	%
Overall	61,584	81.9	13,573	18.1
Age, years				
≤ 19	13,293	21.6	3155	23.2
20–24	24,338	39.5	6058	44.6
25–29	14,296	23.2	2904	21.4
30–34	6499	10.6	1037	7.6
≥ 35	3158	5.1	419	3.1
Race and hispanic ethnicity				
Non-hispanic white	27,677	51.0	6027	48.0
Non-hispanic black	23,566	43.5	6020	47.8
Non-hispanic other	1724	3.2	331	2.6
Hispanic	1269	2.3	206	1.6
Missing	7348		989	
Education				
Less than high school	16,564	26.9	4932	36.4
Completed high school	26,330	42.8	5722	42.2
Some college	15,035	24.5	2582	19.1
College graduate	3554	5.8	310	2.3
Missing	101		27	
Marital status				
Married	43,344	70.4	10,196	75.1
Not married	18,237	29.6	3377	24.9
Missing	3		0	
Area of residence ^a				
Metropolitan	38,555	62.6	8631	63.6
Micropolitan	17,025	27.7	3830	28.2
Rural	6004	9.8	1112	8.2
Prenatal tobacco use				
Yes	11,966	19.4	3383	25.0
No	49,553	80.6	10,169	75.0
Missing	65		21	
Prenatal alcohol use				
Yes	255	0.4	76	0.6
No	61,259	99.6	13,473	99.4
Missing	70		24	
Parity (No. of prior live births)				
0	26,466	43.0	5327	39.3
1	18,097	29.4	4189	30.9
2	10,200	16.6	2381	17.5
3+	6808	11.1	1670	12.3
Missing	13		6	

Table 5 (continued)

	< 4 visits		≥ 4 visits	
	n	%	n	%
Gestational age at delivery, weeks				
< 20	38	0.1	3	0.02
20–27	684	1.1	110	0.8
28–32	1144	1.9	229	1.7
33–36	5105	8.3	1472	10.9
≥ 37	54,613	88.7	11,759	86.6
Multifetal gestation				
Yes	896	1.5	291	2.1
No	60,688	98.5	13,282	97.9
Trimester prenatal care began				
1st trimester	50,120	82.2	11,311	84.3
2nd trimester	9509	15.6	1836	13.7
3rd trimester	982	1.6	229	1.7
No prenatal care	330	0.5	37	0.3
Missing	643		160	
Medical comorbidities ^b				
Diabetes	3517	5.7	959	7.1
Chronic hypertension	1858	3.0	640	4.7
Gestational hypertension	2538	4.1	648	4.8
Preeclampsia	2971	4.8	748	5.5
Cardiac disease	364	0.6	134	1.0
Lung disease	1784	2.9	792	5.8
Hemoglobinopathy	762	1.2	222	1.6
Mental illness	24,546	39.9	5315	39.2
Gastrointestinal disease	84	0.1	30	0.2
Renal disease	172	0.3	59	0.4
Connective tissue disease	87	0.1	46	0.3
Number of medical comorbidities ^c				
None	28,195	45.8	5676	41.8
One	28,631	46.5	6407	47.2
Two or more	4,758	7.7	1490	11.0

^aCategorized according to the US Census Bureau’s core based statistical areas

^bCategories are not mutually exclusive

^cComorbidities include the 11 conditions mentioned above

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