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Alexa Campbell Date

Demographic and Clinical Predictors of Postpartum Blood Pressure Screening Attendance

By

Alexa Campbell

Master of Public Health

Hubert Department of Global Health

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Sheree Boulet, DrPH

Committee Chair

_____

Roger Rochat, MD

Committee Member

Demographic and Clinical Predictors of Postpartum Blood Pressure Screening Attendance

By

Alexa Campbell
B.S., Duke University, 2018

Thesis Committee Chair: Sheree Boulet, DrPH
Thesis Committee Member: Roger Rochat, MD

An abstract of
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Abstract
Demographic and Clinical Predictors of Postpartum Blood Pressure Screening Attendance
By Alexa Campbell

Hypertensive disorders of pregnancy (HDP) are a leading cause of preventable maternal and neonatal morbidity and mortality. Postpartum hypertension that develops after women leave the hospital is particularly dangerous, as it can go undiagnosed and cause complications. The American College of Obstetricians and Gynecologists recommends women with HDP have a blood pressure (BP) check one week after delivery to detect postpartum hypertension. Yet, little is known about attendance at the BP check visit or the clinical and demographic predictors of attendance. The goal of this study was to describe the demographic and clinical predictors of postpartum BP screening attendance among a high-risk, safety-net population in the Southeast.

We conducted a population-based cohort study of pregnant women who delivered at a large public hospital in Atlanta between July 1, 2016 and June 30, 2018. We manually abstracted data on demographic and clinical characteristics of participants, yielding 1,360 women with HDP. Among this sample of mostly non-Hispanic black, publicly insured women, 23.8% attended a BP check within three weeks postpartum. In a multivariable log binomial regression model, severe HDP (aRR 2.29, 95% CI 1.57-3.33) and Cesarean delivery (aRR 1.61, 95% CI 1.21-2.15) were positive predictors of BP check attendance. Negative predictors included low PNC utilization (aRR 0.32, 95% CI 0.20-0.50), non-Hispanic black race/ethnicity (aRR 0.50, 95% CI 0.28-0.88), higher parity (aRR 0.63, 95% CI 0.43-0.93), and public insurance (aRR 0.68, 95% CI 0.39-1.15).

Among a high-risk, safety-net population with HDP in the Southeast, most women are not getting their BP screened within three weeks postpartum. Addressing this gap will require additional research and creative solutions to address barriers at the individual-, provider-, and system-levels.

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Introduction

Hypertensive disorders of pregnancy (HDP) are a leading cause of preventable maternal and neonatal morbidity and mortality, both in the U.S. and globally. Among countries classified as "developed" by the World Health Organization (WHO), 16.1% of maternal deaths are attributable to HDP (American College of Obstetricians and Gynecologists [ACOG] Task Force on Hypertension in Pregnancy, 2013; Khan, Wojdyla, Say, Gülmezoglu, & Van Look, 2006). The term HDP refers to several conditions that develop during pregnancy or in the postpartum period (in order of severity): preeclampsia with severe features, preeclampsia without severe features, gestational hypertension, and chronic hypertension; preeclampsia with or without severe features may also be superimposed on chronic hypertension (ACOG Task Force on Hypertension in Pregnancy, 2013). Severe cases of HDP may lead to serious complications, including eclampsia, characterized by seizures, and Hemolysis, Elevated Liver enzymes, Low Platelet count (HELLP) syndrome. Collectively, HDP are common complications, with a prevalence in the U.S. of 5-8% of all pregnancies (Umesawa & Kobashi, 2017; Zhang, Meikle, & Trumble, 2003). In addition to the serious consequences for mothers, HDP contribute to stillbirth and neonatal death (C. V. Ananth & O. Basso, 2010; Zhang et al., 2003). Yet, a majority of the morbidity and mortality associated with HDP can be prevented given detection and appropriate treatment (Umesawa & Kobashi, 2017).

While understanding of the pathogenesis of HDP has improved in recent years, rates have been on the rise in the U.S. since the late 1980s (Kuklina, Ayala, & Callaghan, 2009; Wallis, Saftlas, Hsia, & Atrash, 2008). This is particularly concerning because of the disparities in HDP occurrence and severity. For example, black women have 1.5-fold higher rates of preeclampsia

with severe features and eclampsia and are more likely to experience severe resulting complications than their non-Hispanic white counterparts (Cande V. Ananth & Olga Basso, 2010; Samadi et al., 1996; Tanaka et al., 2007; Zhang et al., 2003). Some of these resulting complications are serious enough to be classified as severe maternal morbidity (SMM), which encompasses unexpected complications caused or exacerbated by pregnancy that significantly impact health (Centers for Disease Control and Prevention, 2017). Hypertensive disorders are a large contributor to the overall burden of SMM, with HDP shown to be related to SMM by a dose-dependent relationship: preeclampsia with severe features has a stronger association with SMM than do less severe hypertensive disorders (Hitti, Sienas, Walker, Benedetti, & Easterling, 2018; Kuklina et al., 2009; Zhang et al., 2003). The relationship between HDP and maternal morbidity and mortality is illustrated in the large number of Emergency Department (ED) visits and hospital readmissions in the postpartum period. In one study, 20% of women who presented to the ED postpartum were subsequently diagnosed with HDP. Among this group, 58% were readmitted to the hospital after their triage visit; in comparison, only 12% of those who presented to the ED for reasons other than a hypertensive disorder were ultimately readmitted (Brousseau, Danilack, Cai, & Matteson, 2017). Similar trends have been observed elsewhere in the literature, like in one large, multi-state study that identified hypertension as a major cause of hospital readmission in the postpartum period, with 16.4% of readmissions including hypertension as a primary or secondary diagnosis (Clapp, Little, Zheng, & Robinson, 2016). Beyond complications in the postpartum period, HDP have been linked with serious long-term health risks, including cardiac disease and mortality, stroke, chronic hypertension, diabetes mellitus, and end-stage renal disease (ACOG Task Force on Hypertension in Pregnancy, 2013; Umesawa & Kobashi, 2017).

While most of the literature on HDP focuses on antenatal HDP, it is not uncommon for HDP to persist or develop de novo in the postpartum period (Tan & de Swiet, 2002). Postpartum hypertension (PPHTN) is thought to develop in part due to extracellular fluid mobilization that occurs in the immediate puerperium, which can be exacerbated by intravenous fluid administration during labor and delivery, and nonsteroidal anti-inflammatory drugs, which are commonly used for pain management following delivery (Ghuman, Rheiner, Tendler, & White, 2009). In observational studies, blood pressure usually dips immediately after delivery and then begins rising, peaking between 3-6 days postpartum (B. N. Walters, Thompson, Lee, & de Swiet, 1986; B. N. J. Walters & Walters, 1987); this has important implications for detection of PPHTN, as most women are discharged from the hospital prior to this point (ACOG Task Force on Hypertension in Pregnancy, 2013). Because of this, women are counselled to present to care if warning signs for PPHTN develop, such as headaches and visual changes; however, women often wait hours to days after symptoms develop before seeking care (Bernstein et al., 2017; A. Goel et al., 2015). This can result in dangerous complications, like eclamptic seizures, developing due to delayed intervention (Tan & de Swiet, 2002).

In order to identify PPHTN before serious complications occur, ACOG recommends that women diagnosed with HDP have a blood pressure (BP) check approximately one-week after delivery, or earlier if symptoms develop (ACOG Task Force on Hypertension in Pregnancy, 2013). Yet, little is known about attendance rates for the one-week BP check visit or the clinical and demographic factors that influence attendance. The six-week postpartum visit, in contrast, has been a long-standing practice and attendance rates and factors that influence attendance for this visit are well documented in the literature. Attendance at the six-week visit is as low as 60% overall in the U.S., but attendance is lower among already disadvantaged groups (McKinney,

Keyser, Clinton, & Pagliano, 2018). Frequently cited attributes more common among those who did not attend their post-partum visit include younger age, low prenatal care utilization, publicly insured or uninsured, having multiple children, being unmarried, and low education level (Baldwin, Hart, & Rodriguez, 2018; DiBari, Yu, Chao, & Lu, 2014; Levine, Nkonde-Price, Limaye, & Srinivas, 2016; Rodin, Silow-Carroll, Cross-Barnet, Courtot, & Hill, 2019; Wilcox, Levi, & Garrett, 2016). Whether these factors or others influence attendance at the one-week BP-check is currently unknown.

Problem Statement

HDP commonly complicate pregnancies and require monitored care to track symptom progression and swiftly implement interventions as needed (Bernstein et al., 2017). When hypertensive disorders occur in the postpartum period, symptoms like severe headache, visual changes, and abdominal pain usually begin hours to days before serious complications like eclampsia develop, providing an opportunity to avert morbidity and mortality through timely detection and intervention (Matthys, Coppage, Lambers, Barton, & Sibai, 2004). However, complications often occur after women have been discharged from the hospital postpartum, which may lead to delays in care seeking and intervention, even when warning signs develop and are recognized as such (Bernstein et al., 2017; Arvind Goel et al., 2015). The recommendation for a BP check one week after delivery was issued by ACOG to avert some of the morbidity and mortality caused by PPHTN; yet, little is known about patient attendance and efficacy of this visit (Ehrenthal, Maiden, Rogers, & Ball, 2014). One study of postpartum readmissions (n=151) for HDP found that 10% of the readmissions were the result of home health evaluations, despite the women having symptoms before this check (Matthys et al., 2004). While home health

evaluations differ from clinic-based BP checks, this still provides evidence that BP screening can prompt healthcare seeking better than counselling on warning signs.

Data on clinical and demographic characteristics of women attending the standard six-week postpartum visit are readily available in the scientific literature, but similar analyses of attendance for the one-week BP check do not exist (Cairns et al., 2017). Understanding the population characteristics that alter likelihood of attendance is important for both healthcare workers and public health professionals. On an individual level, healthcare workers can tailor counselling and recommendations for patients based on this type of information. At a larger scale, data on clinical and demographic characteristics associated with visit attendance are crucial for developing targeted interventions to improve adherence and for testing alternative strategies, like using home BP monitors for high-risk populations, to reduce PPHTN morbidity and mortality among those less likely to attend this follow-up visit.

Purpose Statement

In order to fill the knowledge gap about attendance at the one-week BP check, we conducted a retrospective analysis of 3,723 women who gave birth at Grady Memorial Hospital, a large public hospital in Atlanta, between July 1, 2016 and June 30, 2018. For this cohort, data from electronic medical records were abstracted, including demographic and clinical characteristics. Moreover, for those diagnosed with HDP, information was collected about whether they attended their BP check visit within three weeks of delivery, and if so, whether their BP was elevated, as well as if they were readmitted postpartum due to complications from a hypertensive disorder. Following data collection, I conducted a descriptive analysis with the goal of exploring

associations between demographic and clinical characteristics and BP follow-up visit attendance. First, I conducted a descriptive analysis of demographic and clinical characteristics by BP check visit attendance to identify factors that altered likelihood of attendance. Then, I conducted a multivariable analysis to examine how specific determinants were related to visit attendance when controlling for other variables.

Research Objectives:

1. Describe the differences among women diagnosed with HDP in demographic and clinical characteristics between women who attended a postpartum BP check and those that did not.
2. Fit a log binomial regression model using demographic and clinical characteristics to predict postpartum BP check attendance.

Significance Statement

Addressing the gap in knowledge about factors associated with one-week BP check attendance is important from a clinical and population health perspective. Knowing which clinical and demographic characteristics are associated with lower attendance rates may help physicians, nurses, and other healthcare workers in counselling patients. A healthcare worker may take more time to thoroughly explain risks and purpose of the visit in order to increase attendance to the BP check among patients that may be less likely to attend the follow-up visit. Alternatively, healthcare workers may work with that same group to find other options to the one-week visit, such as using a home BP monitor.

For public health professionals, closing this knowledge gap provides an opportunity to develop interventions focused on PPHTN and follow-up visit attendance. If there are significant

differences in BP check follow-up attendance among different groups, that presents an opportunity for targeted interventions to improve follow-up rates. With rates of HDP on the rise, identifying the women least likely to return for blood pressure screening is especially important. Particularly if women at high risk for morbidity have low follow-up rates, these findings can inform development of alternate BP monitoring strategies.

Definition of Terms

- *Hypertensive Disorders of Pregnancy:* Chronic or de novo hypertensive disorders complicating pregnancy including chronic hypertension, preeclampsia, eclampsia, preeclampsia superimposed on chronic hypertension, and gestational hypertension (ACOG Task Force on Hypertension in Pregnancy, 2013)
- *Gestational Hypertension*: Systolic BP of 140 mmHg or more, or a diastolic BP of 90 mmHg or more, measured on two or more occasions at least four hours apart among women after 20 weeks of gestation without previously diagnosed chronic hypertension (ACOG, 2019)
- *Chronic Hypertension*: Systolic BP 140 mmHg or greater, diastolic BP 90mmHg or greater, or both, measured twice at least four hours apart prior to 20 weeks gestation (ACOG Task Force on Hypertension in Pregnancy, 2013)
- *Preeclampsia without Severe Features*: Women meeting both of the following criteria: (1) Systolic BP 140 mmHg or greater, diastolic BP 90 mmHg or greater, or both, measured twice at least four hours apart after 20 weeks gestation in a woman with previously normal BP, and (2) Proteinuria (ACOG Task Force on Hypertension in Pregnancy, 2013)

- *Preeclampsia with Severe Features*: women who develop…
    - One of the following:
        - Systolic BP 140 mmHg or greater, diastolic BP 90 mmHg or greater, or both, measured twice at least four hours apart after 20 weeks of pregnancy
        - Systolic BP 160 mmHg or greater, diastolic BP 110 mmHg or greater (severe hypertension may be confirmed within a short interval (minutes) to facilitate timely antihypertensive therapy
    - AND one or more the following:
        - Proteinuria
        - Thrombocytopenia: Platelets < 100,000 x 10^9/L
        - Renal Insufficiency: Creatinine > 1.1 mg/dL or a doubling of the serum creatinine concentration from the patient's baseline in the absence of other renal disease
        - Impaired liver function: Liver function tests (ALT and AST) greater than two times the upper limit of normal
        - Pulmonary Edema on the basis of chest XRAY findings or oxygen supplementation
        - Severe headache or visual symptoms unresponsive to other medication, and not accounted for by alternative diagnosis and treated with IV Magnesium(ACOG Task Force on Hypertension in Pregnancy, 2013)
- *Proteinuria*: 24-hour protein excretion ≥ 300mg, or P:C (Protein: Creatinine) > 0.3 mg/dL in a single voided urine (ACOG Task Force on Hypertension in Pregnancy, 2013)

- *HELLP Syndrome:* Lactate dehydrogenase (LDH) elevated to 600 IU/L or more, aspartate aminotransferase (AST) and alanine aminotransferase (ALT) elevated more than twice the upper limit of normal, AND the platelets count less than 100,000 x 109/L (ACOG Task Force on Hypertension in Pregnancy, 2013)
- *Eclampsia:* New onset seizures in a pregnant or postpartum patient greater than 20 weeks gestation without an underlying seizure disorder or other etiology for seizure (e.g. no evidence of new intracranial mass, electrolyte abnormality, toxicity, hypoglycemia) with other evidence of preeclampsia (ACOG Task Force on Hypertension in Pregnancy, 2013)
- *Superimposed Preeclampsia*: Preexisting chronic hypertension with worsening blood pressures and/or new onset or worsening proteinuria after 20 weeks of gestation (ACOG Task Force on Hypertension in Pregnancy, 2013)

Literature Review

Rising rates of HDP in the U.S. pose a threat to women's and infants' health because of the strong association between HDP and short- and long-term morbidity and mortality (ACOG Task Force on Hypertension in Pregnancy, 2013; Khan et al., 2006; Kuklina et al., 2009; Wallis et al., 2008). ACOG recommends all women return for a postpartum visit approximately six weeks after delivery, and women who are diagnosed with HDP are additionally recommended to return one week after delivery for a BP screening (ACOG Task Force on Hypertension in Pregnancy, 2013). This BP check visit recommendation was instituted to detect PPHTN and initiate treatment before complications arise ("Severe Maternal Morbidity in the United States,"). Although women diagnosed with HDP are counselled before discharge to return upon onset of PPHTN warning signs, like severe headache and visual changes, many women will wait hours to days before seeking healthcare, if they do return at all (Bernstein et al., 2017; A. Goel et al., 2015). The goal of this literature review is to describe correlates of attendance at the postpartum BP check and 6-week postpartum visit and to identify key gaps in the literature.

To identify literature for this review, I first searched Google Scholar for articles related to women with HDP and postpartum follow-up by searching for titles/abstracts including the terms "postpartum" and "follow up" or "attendance" with at least one of the following terms: "hypertension", "hypertensive", "HDP", or "preeclampsia". An equivalent search was duplicated in PubMed. This yielded a small group of articles that mostly focused on women with HDP and/or gestational diabetes mellitus (GDM). Additionally, I reviewed article references to identify any related articles that I missed related to women with HDP. Next, I conducted a broader search to identify any research that examined predictors of postpartum visit attendance. I

searched Google Scholar for the terms “postpartum” and either “follow-up” or “attendance” in the title or abstract, and then replicated the search in PubMed. Once again, I examined references to identify any applicable research that had been missed. Finally, to identify articles examining predictors of postpartum diabetes screening, I searched Google Scholar for the terms “postpartum” and either “follow-up” or “attendance” in the title or abstract with one of the following terms: “GDM”, “diabetes”, “GTT”, “glucose tolerate test”, or “fasting plasma”. All the searches were restricted to English-language articles. In order to ensure these findings were as applicable as possible to the one-week postpartum visit, I did not include research that looked at primary care utilization or postpartum care that occurred outside of the United States. However, I included systematic reviews if they reviewed articles both based in the U.S. and globally. Additionally, I excluded research primarily examining interventions.

Postpartum Blood Pressure Screening Rates

In the scientific literature, there is one abstract, published in January 2020, that explores predictors of postpartum BP screening attendance (Romagano, Sachdev, et al., 2020). The authors observed several predictors of postpartum BP screening, many of which were indicative of higher follow-up rates among women with more severe cases of HDP. Additionally, African American race was associated with lower likelihood of follow-up. Other than this, two published studies report attendance rates for postpartum BP screening among women with HDP (Jones, Hernandez, Edmonds, & Ferranti, 2019).

Romagano, Sachdev, et al. (2020) investigated predictors of attendance at a BP screening visit between 3-10 days post-delivery. This analysis was, however, derived from a different study that

implemented a protocol providing verbal and written post-birth warning sign instructions to women who delivered at an urban, academic healthcare facility. Women in the pre- and post-intervention groups were included in the analysis of BP screening attendance, and attendance rates did not significantly differ between the two groups (Romagano, Flint, et al., 2020). They observed many variables that correlated with BP screening attendance in bivariable analysis; no multivariable analysis was included in the abstract. Variables that increased likelihood of attendance included older age (mean for those who attended: 29.8, mean for those who did not attend: 27.7, p=0.002), a diagnosis of preeclampsia (crude odds ratio (cOR) 2.05, 95% CI 1.33-3.13), presence of severe features (cOR 1.78, 95% CI 1.15-2.82), Cesarean delivery (cOR 3.67, 95% CI 2.26-5.94), antihypertensive medication use in pregnancy (cOR 3.07, 95% CI 1.25-7.57), magnesium sulfate prophylaxis (cOR 1.80, 95% CI 1.16-2.78), a postpartum ED visit (cOR 3.07, 95% CI 1.25-7.57), and postpartum furosemide use (cOR 2.08, 95% CI 1.27-3.45). Additionally, factors that were associated with lower likelihood of follow-up included African American race (cOR 0.54, 95% CI 0.36-0.82) and gestational hypertension diagnosis (cOR 0.55, 95% CI 0.36-0.83). Notably, many of the characteristics associated with greater postpartum follow-up are indicative of more complicated pregnancies requiring more intensive interventions. This suggests that those with the most severe cases of HDP are the most likely to return, which is a good sign, as these patients may be the most likely to experience postpartum complications. Yet, the overall rate of follow-up was only 51%, so there were many women who did not get a BP check in a timely manner. As women were only considered to have attended if their BP check occurred between 3-10 days post-delivery, it is possible some people did attend a BP screening visit but did so late. However, because most postpartum complications occur within approximately one-

week post-delivery, it is important that BP checks occur in a timely manner, which is what this study is measuring (B. N. J. Walters & Walters, 1987).

Other literature only reported rates of BP follow-up, and not individual predictors, as the rates reported were very high (97.9-100%) (Jones et al., 2019). Ehrenthal et al. investigated patterns in postpartum healthcare follow-up among a prospective cohort of women with HDP and/or GDM who delivered in an academic obstetric hospital located in the mid-Atlantic region (Ehrenthal et al., 2014). Participants were interviewed and surveyed during their delivery hospitalization and then again three months postpartum; for the three-month visit, they were compensated for time and travel costs. This yielded a final sample of 176 women who completed both time points, representing 70% of the original sample of 249 women. Demographically, the study cohort was mostly white (65%) and privately insured (70%). Those lost to follow-up had, on average, lower levels of education than those who attended the follow-up study visit, but there were no other differences in the demographic or clinical measures collected. Among the 95 study participants diagnosed with HDP, 93 (97.9%) self-reported attending follow-up BP screening postpartum; however, the generalizability of this finding is limited because the measure was self-reported. This may have led to falsely elevated attendance rates because of social desirability bias. Secondly, the study population only represents women who chose to attend the three-month follow-up visit for this research study, who had higher levels of education than did those who did not attend the follow-up. This may also translate to a population that is more adherent to medical care and therefore more likely to attend BP testing than the general population. Finally, women were asked to report if they attended follow-up screening within the three months between delivery and the follow-up interview, so the figure does not represent BP testing that occurred

approximately one week postpartum, which is when women are most at risk for PPHTN (ACOG Task Force on Hypertension in Pregnancy, 2013).

Levine et al. also examined predictors of postpartum follow-up among women with pregnancy complications, but specifically looked at women with preeclampsia with severe features (Levine et al., 2016). The cohort study included women who were diagnosed with preeclampsia prior to active labor, had singleton gestations, and delivered after 34 weeks of gestation at the University of Pennsylvania Hospital. Data on clinical and demographic information was abstracted from the electronic medical record as a planned secondary analysis of a sample of 193 women, which included a large number of obese (50%) and black (77%) women. The postpartum follow-up rate for a six-week visit was only 52.3%, but all who followed up also completed follow-up BP testing. Like Ehrenthal et al., this BP testing rate includes any testing within six weeks of delivery, limiting its usefulness in estimating BP follow-up that occurs approximately one-week after delivery. Additionally, this finding may reflect the fact that BP measurement frequently occurs during the six-week postpartum visit, rather than represent frequent BP testing at a visit distinct from the traditional postpartum visit.

While Ehrenthal et al. and Levine et al. demonstrate that blood pressure testing frequently occurs within approximately 6-12 weeks postpartum among women with HDP, neither study sheds light on when BP screening occurs. Romagano et al. provide insight into what one-week BP screening rates may be and what characteristics may increase likelihood of screening attendance. However, their analysis is limited because they only published a bivariable analysis. Therefore, severity of HDP may be an unaccounted-for covariate influencing the relationships they observed.

This study aims to build on the work by Romagano et al. by determining clinical and demographic characteristics associated with attending a BP screening visit within three weeks of

delivery. Additionally, it focuses on a high-risk, largely Medicaid-insured population in the Southeast in which HDP, chronic conditions, and other complications of pregnancy are common (Kuklina et al., 2009). Moreover, with multivariable analysis, this study can identify the independent effects of demographic and clinical characteristics on BP check attendance, providing insight into who is most at risk of non-attendance.

Predictors of Postpartum Visit Attendance

Because there is so little information on BP screening available, the rest of this literature review aims to identify clinical and demographic predictors of other postpartum visits, specifically the traditional postpartum visit that typically occurs six weeks post-delivery, and the diabetes screening visit for women with GDM, which is recommended at four to twelve weeks postpartum (ACOG, 2018).

While there is only one published abstract on the determinants of attending a BP screening visit one week postpartum, the predictors of attending the traditional postpartum have been extensively studied. This visit serves a different purpose than a BP screening, and it occurs at a different time postpartum; these distinctions make the comparison between the two visits limited. This is especially true because most of the research designated women as having attended a postpartum visit even if it occurred much later than six weeks postpartum in order to capture all attendances, even if they are not within the recommended timeframe. Yet, the literature on the six-week postpartum visit can provide clues on which variables may be important in predicting BP check follow-up. Despite their differences, both visits require women to return to a healthcare

setting after delivery in order to access care, which may mean some of the same barriers and promoters for attendance apply.

This literature review includes studies that investigate predictors of postpartum attendance rates, including studies that are specific to women with pregnancy complications or women with specific insurance types. The data from the included studies are primarily drawn from insurance claims(Bennett et al., 2014; Masho et al., 2018; Thiel de Bocanegra et al., 2017; Weir et al., 2011) or medical record abstraction,(Baldwin et al., 2018; Battarbee & Yee, 2018; Chen, Hsia, Hou, Wilson, & Creinin, 2019; Levine et al., 2016; Ortiz, Jimenez, Boursaw, & Huttlinger, 2016; Wilcox et al., 2016) though a few studies collected data directly from women through surveys or interviews(DiBari et al., 2014; Morgan, Hughes, Belcher, & Holmes, 2018) and one is a systematic review (Jones et al., 2019). Data sources limited the variables each study was able to collect from their populations, but clinical and demographic characteristics that were frequently included in models include race/ethnicity, age, parity, insurance type, and mode of delivery. Other variables, including marital status, smoking status, education level, and income level have also been frequently included in studies of postpartum attendance. The included articles are summarized in Table 1.

Race/Ethnicity

While there were differences in how race/ethnicity was associated with postpartum follow-up across studies, one general trend is that black race decreased likelihood of postpartum follow-up (Jones et al., 2019; Thiel de Bocanegra et al., 2017). There are contradicting findings on Hispanic ethnicity, as it has been found to be both a positive and negative predictor of postpartum follow-up (Bennett et al., 2014; DiBari et al., 2014; Masho et al., 2018; Ortiz et al., 2016; Thiel de

Bocanegra et al., 2017; Wilcox et al., 2016). Evidence on how other races/ethnicities predict postpartum follow-up is even less consistent across studies.

Bennett et al. (2014) studied postpartum care in women with GDM, HDP, and pregestational diabetes mellitus (DM) (n=7741) as compared to a group of women without any of these three complications (n=23,599). Data were collected through an analysis of insurance claims made in Maryland, with the majority of claims made to Medicaid. Commercial insurance claims lacked racial/ethnic information, so postpartum follow-up rates by race were only available for the Medicaid subset of the study population (n=23,692). In this group, the odds of follow-up at a postpartum visit were higher for white (adjusted odds ratio (aOR) 1.22, 95% CI 1.14-1.31) and Hispanic (aOR 1.28, 95% CI 1.28-1.70) women when compared to Black women. The model also included race/ethnicity, age, pregnancy and delivery complications, chronic illnesses, substance use, mental health, insurance coverage, and neighborhood demographic characteristics. While Hispanic ethnicity appears to be a predictor of greater attendance among this group, this study only compares Hispanic women with black women, rather than comparing Hispanic women to non-Hispanic women. Additionally, this analysis does not consider the racial identity of Hispanic women, as “Hispanic” was treated as a race category. This limitation is likely due to coding of race and ethnicity in the Medicaid claims data.

Battarbee and Yee (2018) examined barriers to postpartum follow-up within four months among women with GDM (n=683) who delivered in Chicago. In multivariable analysis, only Asian race was a statistically significant predictor of postpartum follow-up when compared to non-Hispanic white women (aOR 4.2, 95% CI 1.1-15.3), although non-Hispanic black race/ethnicity had increased odds of follow-up in bivariable analysis (cOR 3.0, 95% CI 1.0-9.0). The adjusted model controlled for age, insurance, marital status, parity, tobacco use, timeliness of PNC

initiation, preterm delivery, and gestational age at GDM diagnosis. One limiting factor is the facility from which the study population was drawn: because it is a tertiary medical center, it is possible that some patients may have been transferred in for care but returned to their referring provider for postpartum care. This is more likely to have happened in this study population because it is made up of women with complicated pregnancies, as they all were diagnosed with GDM.

Ortiz, Jiminez, Boursaw & Huttlinger (2016), like Battarbee and Yee, examined trends in postpartum care for women diagnosed with GDM. The sample was drawn from women giving birth at a large tertiary facility, but unlike Battarbee and Yee, data from the sample was collected through medical record abstraction rather than from insurance claims. The New Mexico-based study (n=97) was largely made up of Hispanic participants (60%), but also had a large proportion of women who identified as American Indian (16%). Additionally, a significant portion of the sample was uninsured (43%), with an approximately equal share insured publicly (39%) through Medicaid or Indian Health Services (IHS). Among the participant pool, non-Hispanic white women were significantly more likely to attend a follow-up visit than any other racial/ethnic group in bivariable analysis: 91% of non-Hispanic white women had a documented postpartum visit, compared to 67% of women in other racial categories. No multivariable analysis was done, which presents an important limitation.

Jones et al. (2019) conducted a systematic review examining postpartum follow-up trends among women with GDM or HDP and ultimately identified nine observational studies through a search of MEDLINE for studies from January 2011 through October 2018. Among the included articles are Bennett et al., Battarbee & Yee, and Ortiz et al. Of the nine articles included in the review, five identified race/ethnicity as a predictor for postpartum follow-up, with black and Hispanic

women less likely to follow-up, and non-Hispanic white, Asian, and other non-black women were more likely to follow-up. This included findings from Levine et al., who observed a 47% follow-up rate among black women as compared to non-black women who had a 70.5% follow-up rate at the postpartum visit (cOR 0.37, 95% CI 0.18–0.77) in a study of women diagnosed with preeclampsia with severe features (2016). As the results of the review are already included in the summary table (Table 1) by individual study, this article was not included in the table to avoid redundancy.

Contradicting the association between black race and lower postpartum follow-up attendance is an investigation by Masho et al. (2018), who examined postpartum visit correlates among women with Medicaid. In this large (n=25,692) analysis of Medicaid claims data in Virginia, the sample was more than half white (56%) and high school educated (51%). Among this cohort, black women were more likely to attend their postpartum follow-up visit in comparison with white women (aOR 1.22, 95% CI 1.05-1.42), as were those of "other" race/ethnicity (not Hispanic, black, or white) (aOR 1.26, 95% CI 1.04-1.54). The adjusted model controlled for age, education, location of services, region of residence, PNC use, history of depression, pregnancy complications, substance use, mode of delivery, preterm birth and low birth weight.

A study examining postpartum follow-up among women delivering at two hospitals in the Bronx by Wilcox, Levi & Garrett (2016) also identified Hispanic ethnicity as a negative predictor for postpartum visit attendance. The study sample included 3,441 mostly black or multiracial women after excluding women who did not receive prenatal care at one of the hospitals and those who did not report their race and/or ethnicity. Data were collected from an electronic records system database that integrates demographic and clinical information, and postpartum visit attendance within 12 weeks of delivery was determined from The International Classification of Diseases,

Ninth Revision (ICD-9) codes. In this cohort, Hispanic women were less likely to attend a postpartum follow-up visit when compared to non-Hispanic women (aRR 0.83, 95% CI 0.77-0.91) in a multivariable model controlling for age, ethnicity, and insurance status. Exclusion of women who chose not to report race/ethnicity, which removed 608 women from the cohort, may be a limitation of the findings, however.

Thiel de Bocanegra et al. (2017) conducted an analysis of postpartum care patterns among women in California's Medicaid program, drawing data from both insurance claims and electronic medical records. The large (n=199,860), prospective study was made up of majority Hispanic women (67%), and only 50% of the cohort spoke English. In the multivariable analysis, black women were less likely to attend a postpartum visit within 21-56 days of delivery when compared to white women (aOR 0.73, 95% CI 0.71-0.76). Hispanic ethnicity did not impact likelihood of postpartum visit attendance; however, primary language spoken was also included in the final model, which found a 65% higher odds of attendance among those who spoke Spanish primarily compared to those whose primary language was English (aOR 1.65, 95% CI 1.61-1.69). It is unclear whether primary language spoken and ethnicity were examined for collinearity; if not, it is possible there are higher odds for visit attendance among Hispanic women than this model suggests. The logistic regression model controlled for race/ethnicity, primary language, age at delivery, residence in a primary care shortage area, delivery method, and participation in state-funded health care programs.

Also identifying Hispanic ethnicity as a promoter of postpartum follow-up is an investigation by DiBari et al. (2014). This study used data collected for the Los Angeles Mommy and Baby (LAMB) study, which was a cross-sectional, population-based study that mailed surveys to collect information from mothers within six months of delivery in 2007. The 10,000 mailed

surveys yielded a final sample of 4,075 women, who were predominantly Hispanic, low income (annual income <$20,000), and had a low level of formal education (high school-level or less). Completed surveys were linked to birth certificate data, which provided race/ethnicity data, but all other variables were collected through self-report. In multivariable analysis controlling for age, marital status, pregnancy intendedness, PNC use, care prior to pregnancy, preterm/low birth weight, newborn visit attendance, and insurance status, Hispanic women were more likely to attend a postpartum visit than non-Hispanic white women (aOR 1.56, 95% CI 1.04-2.33). This finding contradicts those found by Ortiz et al., but is consistent with the results of the study from Thiel de Bocanegra et al. While all three studies had samples largely made up of Hispanic women, DiBari et al. and Thiel de Bocanegra et al. were both conducted in California, whereas Ortiz et al. took place in New Mexico, suggesting possible regional or state differences in how race/ethnicity predicts postpartum attendance. While using a survey as the instrument allowed researchers to collect information on percieved barriers and attitudes, it does present a limitation because of the possibility of response bias and social desirability bias. The use of birth certificate data to capture race/ethnicity is not subject to social desirability bias, but whether women reported attending the postpartum visit may be.

Maternal Age

Age was frequently analyzed as a predictor of postpartum visit attendance and findings were generally consistent. Older women (>30 years old) tended to have higher rates of follow-up (Battarbee & Yee, 2018; Chen et al., 2019; DiBari et al., 2014; Jones et al., 2019; Wilcox et al., 2016), and younger women (<20 years old) tended to have lower rates of postpartum follow-up (Baldwin et al., 2018; Bennett et al., 2014; DiBari et al., 2014; Thiel de Bocanegra et al., 2017;

Weir et al., 2011). Two studies had contradicting findings, with older age associated with lower rates of follow-up, although both examined trends in populations with pregnancy complications, including HDP and GDM (Bennett et al., 2014; Levine et al., 2016).

DiBari et al. identified age as a significant predictor of self-reported postpartum visit attendance in both multivariable and bivariable analysis among their low-income, mostly Hispanic cohort in Los Angeles. In both analyses, women aged 30-39 were significantly more likely to report attending a postpartum visit when compared with women aged 19-29 (aOR 1.47, 95% CI 1.10-1.96). Additionally, mothers aged 16 or younger were less likely to report attending a postpartum visit, although this relationship was not statistically significant (aOR 0.47, 95% CI 0.22-1.03). While these findings are limited by self-reported data, it provides a look at patterns among young, teenage mothers, an age group that is often not included in this research. It is a small sample, with women 16 or under only representing 1.5% of the cohort (n=44), but the finding that they are twice as likely to lack a postpartum visit warrants attention.

While other studies did not look specifically at women 16 years of age and younger, several did examine trends in postpartum attendance among women under 20 years of age. Thiel de Bocanegra et al. conducted their analysis of postpartum care among a similar cohort to DiBari et al., looking at low-income, mostly Hispanic women in California. Although their study only looked at Medicaid enrollees, the results were similar: women under the age of 20 had significantly reduced odds of attending a postpartum visit in comparison to those aged 20-29 (aOR 0.82, 95% CI 0.80-0.85). The large size of the cohort (n = 199,860) and use of insurance claims data bolsters the finding that teenage mothers are less likely to attend postpartum visits, at least among Medi-Cal recipients.

Also examining a population of Medicaid recipients is a study by Weir et al. (2011) that investigated postpartum care adequacy. This cohort (n=1,858) was drawn from Medicaid patients in Massachusetts, resulting in a different sample population than the studies done by Thiel de Bocanegra et al. and DiBari et al., as it was composed of only a minority of black (11%) and Hispanic (22%) women. Nonetheless, they observed a similar pattern among the study cohort, as in multivariable analysis, women aged 14-19 had reduced odds of attending a postpartum care visit between 21 and 56 days postpartum when compared to women aged 20-34 (aOR 0.58, 95% CI 0.40-0.85). Their model was adjusted for race/ethnicity, primary language, disability status, neighborhood income and education demographics, number of children 14 years old or younger in the household, innsurance coverage, ED visits, ambulatory office visits, provider type, overall illness burden, substance use, mental illness, domestic violence, and county of residence. This provides evidence from a different geographic region that younger age is associated with lower likelihood of postpartum follow-up.

On the other end of the age spectrum, older women were more likely to follow-up in most studies, with a couple exceptions. Chen et al. (2019) examined trends in a quasi-experimental study focusing on postpartum attendance among women who either had a postpartum visit scheduled for 6 weeks postpartum, which is typical, or scheduled for 2- to 3- weeks postpartum. While women were initially scheduled for a postpartum visit approximately 2- to 3-weeks postpartum or 6-weeks postpartum, some rescheduled their appointments; therefore, all women who attended a postpartum visit within 12-weeks postpartum were considered to have attended a visit. The sample (n=512) was drawn from women planning to deliver at UC Davis Medical Center and planning to delay their next pregnancy by at least one year; the resulting cohort was largely white (66%), highly educated (3/4 of the cohort at least attended some college), and

privately insured (around 2/3 of the sample). Postpartum visit information and other demographic/clinical data was abstracted from medical records. When comparing women under 30 years old with those ages 30 and up in multivariable analysis, the older group was more likely to attend a follow-up visit by 12 weeks; women under 30 had 50% the odds of visit attendance compared to their older counterparts (aOR 0.51, 0.27-0.97). This model controlled for timing of scheduled postpartum visit, ethnicity, parity, prior miscarriage, pregnancy intendedness, education, and high-risk pregnancy. However, these findings are limited by the demographically homogenous cohort and generally low-risk population.

On the other side of the country, among a cohort of women giving birth at hospitals in the Bronx (n=6489), the same trend was found by Wilcox et al. When comparing postpartum attendance rates by age group in the adjusted model, women over 30 were the most likely to attend a postpartum visit and women under 20 were the least likely to attend a postpartum visit. When compared with those under 20 in multivariable analysis, those ages 30 and older had a statistically significant increased likelihood of attendance (aRR 1.30, 95% CI 1.09-1.56). In this model, ethnicity, insurance type, and mode of delivery were controlled for. Battarbee and Yee examined age as a continuous variable among their cohort of women with GDM, but also observed that women who attended their postpartum visit were significantly older than those who did not attend, although this relationship was only significant in bivariable analysis.

Research from Levine et al. and Bennett et al. on postpartum follow-up after medically complicated pregnancies suggests older age leads to lower follow-up rates, adding complexity to this relationship. Bennett et al. observed lower odds of postpartum follow-up among women with GDM or HDP aged >35 when compared to women aged 18-24, but only among those with commercial insurance (aOR 0.70, 95% CI 0.52–0.93). Among those with Medicaid, they

observed no difference in adjusted odds of follow-up between age groups. Levine et al. only studied women with severe preeclampsia, but among this cohort, women aged 30 or older had only 55% the odds of follow-up as did women under 30 (cOR 0.55, 95% CI 0.29-1.04).

Health Insurance

Insurance status as a predictor of postpartum attendance is mostly consistent across the literature, with public insurance/Medicaid usually predicting lower rates of post-partum follow-up (Baldwin et al., 2018; Battarbee & Yee, 2018; DiBari et al., 2014; Ortiz et al., 2016; Wilcox et al., 2016). A few of the larger studies that collected data through insurance claims information only included women insured by Medicaid, so they could not analyze the effect of insurance on postpartum visit attendance (Masho et al., 2018; Thiel de Bocanegra et al., 2017; Weir et al., 2011). Bennett et al. was the only study that used claims data from private and public insurance companies and was the only study to find that Medicaid was a positive predictor of attending a postpartum visit.

The study authored by Bennett et al. focused on identifying differences in postpartum care between women with and without medically complicated pregnancies. As a result, the postpartum attendance rates are stratified by whether a pregnancy was complicated in addition to by insurance status. Among those with complicated pregnancies (n=7,741), 65% of those insured through Medicaid attended a postpartum visit, compared to 50.8% attendance of those insured commercially. For those with pregnancies not complicated by HDP, GDM and/or DM (n=23,599), 61.5% of those insured through Medicaid attended a postpartum visit, in comparison with 44.6% of those insured commercially attended a postpartum visit. As they created separate

models for those insured by Medicaid and those insured commercially, they did not provide adjusted odds ratios for insurance status. Yet, the differences observed are strengthened by the large size of the study cohort and because higher attendance among Medicaid enrollees is consistent despite pregnancy complication status.

The other articles included in this review that identified insurance status as a predictor of postpartum attendance identified public insurance as a negative predictor of postpartum follow-up, often observing large differences in follow-up by insurance status. Baldwin, Hart, and Rodriguez (2018) conducted an analysis of postpartum follow-up among women enrolled in a clinical trial that focused on IUD use following delivery. The study population (n=197) was drawn from women who delivered at a Portland, OR hospital and intended to have an IUD inserted at their postpartum visit, although whether or not they ultimately chose to do so was not exclusionary. The cohort consisted of mostly non-Hispanic (86%) women educated beyond high school (73%) and was equally split between those insured publicly and privately. In addition to collecting information at study enrollment, data were collected through medical record review. For their sample, private insurance was the strongest predictor of postpartum follow-up, with more than ten times the adjusted odds of follow-up when compared to women with Medicaid (aOR 10.4, 95% CI 3.1-48.1). This multivariable model controlled for age, preterm birth, timing of postpartum visit, timely prenatal care initiation, social support, and a visual analog scale score indicating IUD intention. The generalizability of these findings is, however, limited due to only including women who chose to participate in a clinical trial and due to compensation given to the participants who did return for a postpartum visit (even if they did not receive an IUD).

Also reporting a strong relationship between public insurance and lower postpartum follow-up rates are DiBari et al. and Battarbee and Yee who observed double and triple, respectively, the

odds of attendance among those privately insured when compared to Medicaid enrollees. Among survey respondents, DiBari et al. found significantly higher odds of reporting postpartum attendance among those with private insurance when compared to those with Medi-Cal insurance (OR 2.19, 95% CI 1.54-3.11). While strengthened by large sample size, these findings are limited by use of self-reported attendance through a mail-in survey. Battarbee and Yee examined a cohort of 700 women with GDM and found in multivariable regression that those with Medicaid insurance had reduced odds of attending a follow-up visit within four months of delivery (aOR 0.3, 95% CI 0.2-0.6). The authors seem to have categorized women as either being insured by Medicaid or not being insured by Medicaid, so it is unclear what the make-up of the comparison group is, limiting this finding. While postpartum attendance data were not self-reported, these findings still rely on medical record documentation, and postpartum follow-up was only captured if it occurred at the same institution as delivery.

Wilcox et al. reported a smaller magnitude of difference but still found that insurance status was the strongest predictor of postpartum visit attendance. In bivariable and multivariable analysis, women with Medicaid insurance or no insurance were less likely to return for a postpartum visit when compared to women with private insurance (aRR 0.71, 95% CI 0.63-0.83). In this analysis, the uninsured are included in the same category as those with Medicaid, presenting a limitation. Also providing a limited view but still supporting the negative relationship between public insurance and lower postpartum follow-up are the findings from Chen et al. In bivariable analysis, only 23.7% of those who attended a postpartum visit were insured publicly, compared to 59.7% of those who did not attend a postpartum visit. However, education level and insurance status were highly correlated, so only education level was included in multivariable analysis. Similarly, Ortiz et al. only conducted bivariable analysis, in which women with publicly

provided health insurance were significantly less likely to attend a postpartum visit than those with private insurance (88% with private insurance attended follow-up, compared to 47% of those publicly insured).

Prenatal Care Utilization

Because prenatal care utilization is not as easy to capture as other demographic measures, fewer studies included prenatal care (PNC) in their analyses. Among those that did, all found that PNC utilization was associated with higher rates of postpartum follow-up; however, how PNC utilization was defined variably by study.

Both DiBari et al. and Masho et al. included PNC as a dichotomous variable, grouping women into those who did and did not receive PNC. DiBari et al. observed that women who reported they did not receive PNC had one-third the odds of attending a postpartum visit (aOR 0.32, 95% CI 0.18-0.60). Masho et al. found a similar relationship in multivariable analysis, with women, all of whom were Medicaid recipients in Virginia, who did not attend PNC at significantly reduced odds of attending a postpartum visit (aOR 0.43, 95% CI 0.34-0.55). Both findings are limited because they cannot distinguish, for example, between women who attended one PNC visit late in pregnancy and women who initiated PNC early and attended more than ten visits. However, these findings do establish a relationship between PNC utilization and postpartum visit attendance.

Levine et al. looked at number of PNC visits, classifying women based on if they had five or more PNC visits or not. Among this cohort of women with preeclampsia with severe features, having fewer than five PNC visit significantly predicted lacking a postpartum visit (cOR 0.44, CI

0.20–0.97). The final way PNC utilization was quantified was by comparing gestational age at initiation of PNC. In the analysis from Battarbee and Yee, initiation of care was defined as late if it occurred after 24 weeks gestation; late presentation to care was significantly associated with lower likelihood of postpartum follow-up within four months in the multivariable model (aOR 0.4, 95% CI 0.2-0.7). Like Levine et al., this study only looked at women with medically complicated pregnancies, specifically GDM for Battarbee and Yee. Baldwin et al. used the earlier cut-off of 14 weeks of gestation to divide the study cohort into two groups. The group that initiated PNC before 14 weeks gestation had twice the odds of attending a postpartum visit in multivariable analysis (aOR 2.3, 95% CI 1.0, 5.7). Additionally, Baldwin et al. compared women who missed a scheduled PNC visit with those who had perfect attendance; in bivariable analysis, 85% of those with perfect PNC visit attendance attended their postpartum visit, compared to 66% of those who missed at least one visit. The findings from the study conducted by Weir et al. summarizes PNC as a predictor of postpartum care well: timely prenatal care and adequately frequent prenatal care were positively correlated with postpartum care and with each other. Yet, because institutional studies can usually only capture PNC visits that occur at the study location(s), findings on the relationship between PNC and postpartum follow-up are generally limited.

Parity

While parity is frequently discussed as a predictor of postpartum follow-up, studies were limited by their data collection methods as to whether they were able to capture parity among the participants. The studies that used insurance claims data generally did not measure parity, with the exception of Weir et al., which linked Medicaid data in Massachusetts with insurance claims.

Among those that identified parity as a predictor of postpartum care follow-up, higher parity was associated with lower odds of follow-up, while nulliparity was associated with the greatest odds of follow-up (Baldwin et al., 2018; Battarbee & Yee, 2018; Chen et al., 2019; Weir et al., 2011).

Battarbee and Yee found in multivariate analysis that among the sample of women with GDM, those who were nulliparous were more likely to follow-up within four months postpartum (aOR 1.7, 1.0-2.9). Baldwin et al. identified a similar trend among their cohort of clinical trial participants: women who were multiparous made up a larger proportion of those who did not attend the postpartum visit (66%) than of those who did attend the postpartum visit (42%); however, parity was not included in their multivariate analysis. Chen et al. compared nulliparous women to those with a parity of one, two, and three or greater and observed that those with a parity of three or more had the lowest adjusted odds of returning when compared to nulliparous women (aOR 0.38, 95% CI 0.14-0.99). Women with a parity of one (aOR 0.60, 95% CI 0.31-1.15) or a parity of two (aOR 0.78, 95% CI 0.31-1.97) also had reduced odds of returning when compared to nulliparous women, but the relationship was weaker.

Finally, Weir et al. were unable to measure parity but did have data on number of children in the household. Using this measure as proxy for parity, they observed a dose-response relationship between number of children in the household and odds of attending a postpartum care visit whereby those with no children in the household were the most likely to return and those with four or more children were the least likely to return. In multivariable analysis, women with four or more children living in their household had nearly 50% lower odds of attending a postpartum care visit when compared to nulliparous women (aOR 0.56, 95% CI 0.22-1.11). Women with two to three children (aOR 0.71, 95% CI 0.53-0.95) or one child (aOR 0.78, 95% CI 0.60-1.01) living in their household also had lower odds of returning for a postpartum visit when compared

with nulliparous women. This study includes data on parity for participants, so I will examine the relationship between parity and BP check attendance among our cohort of high-risk women in the Southeast.

Chronic Conditions & Pregnancy Complications

Many articles measured the effect of pregnancy complications and chronic conditions on postpartum visit attendance; however, the kinds of conditions measured varied greatly across the literature. As a result, no clear patterns betweeen any condition and visit attendance are apparent. Masho et al. and Chen et al. grouped many complications into one variable, including slightly different complications between the two studies. While Masho et al. identified higher odds of attendance among women with one of more of the complications included in their cohort of Medicaid recipients, Chen et al. observed lower follow-up rates among women they classified as high-risk. Chen et al. also noted that history of prior miscarriage was associated with higher likelihood of follow-up.

Bennett et al. stratified their cohort by insurance status (commercial vs. Medicaid) and saw contrasting results betweeen the two strata. Among those insured commercially, other mental disorders (which includes all mental disorders other than depression) were associated with higher follow-up postpartum (aOR 1.43, 95% CI 1.08-1.88). Yet, among those insured by Medicaid, comorbid mental disorders other than depression were associated with lower likelihood of postpartum follow-up (aOR 0.81, 95% CI 0.75-0.89). Other conditions with significant associations with postpartum follow-up among the Medicaid group all predicted greater attendance rates: chronic hypertension (aOR 1.28, 95% CI 1.05-1.57), preeclampsia (aOR 1.30,

95% CI 1.11-1.52), GDM (aOR 1.14, 95% CI 1.03-1.26), and depression (aOR 1.22, 95% CI 1.07-1.40).

Levine et al. and Battarbee and Yee both examined cohorts composed of women with pregnancy complicated by preeclampsia with severe features and GDM, respectively, but still noted associations between other comorbid complications and postpartum attendance. Levine et al. noted that, in bivariable analysis, women with chronic diabetes in addition to their preeclampsia were four times more likely to attend a follow-up visit postpartum (cOR 4.00, 95% CI 1.09-14.66). Among Battarbee and Yee's cohort of women with GDM, those with a preterm delivery were less likely to follow-up within four months postpartum in their multivariable analysis (aOR 0.4, 95% CI 0.2–0.7).

This investigation looks only at women with complications, as all the participants have HDP; however, I will look at how BP check follow-up rates vary by HDP type. Additionally, I will examine the relationship between BP check attendance and other comorbid conditions, like GDM.

Mode of Delivery

Of the four studies that found mode of delivery to be a significant predictor of postpartum visit attendance, three saw higher follow-up rates among those who delivered via Cesarean section (Bennett et al., 2014; Levine et al., 2016; Wilcox et al., 2016), and only one observed higher follow-up rates among those who delivered vaginally (Thiel de Bocanegra et al., 2017). Levine et al. observed that women who had a Cesarean-section had 2.61 times the unadjusted odds (95% CI 1.40-4.88) of returning for a postpartum visit when compared to women who delivered vaginally among their cohort of women with preeclampsia with severe features.

Because the cohort is restricted to women with preeclampsia, this relationship may be confounded by severity of preeclampsia, as the most severe may have been more likely to deliver via Cesarean section. Moreover, the analysis was limited to bivariable comparisons, so this relationship does not control for other variables. Wilcox et al. saw a similar relationship between Cesarean delivery and postpartum visit attendance among their New York City-based cohort: those who delivered vaginally had a lower likelihood of attending a follow-up visit (aRR 0.83, 95% CI 0.71-0.91) when compared to those who had a Cesarean section. Finally, Bennett et al. also observed higher postpartum follow-up rates among women who had Cesarean sections when compared to those who delivered vaginally (aOR 1.29, 95% CI: 1.22-1.38) among women covered by Medicaid in Maryland.

Reporting contrasting results is the 2017 study from Thiel de Bocanegra et al., which identified lower odds of returning for a postpartum visit for those who delivered via Cesarean-section (aOR 0.81, 95% CI 0.80-0.83). This cohort of nearly 200,000 women was largely Hispanic and Spanish-speaking women, all of whom were insured by California's Medi-Cal program. This study has mode of delivery data that will be utilized to examine if delivery mode is associated with BP check attendance among this cohort of women with HDP.

Substance Use

Across the identified studies, smoking (Battarbee & Yee, 2018; Masho et al., 2018) and alcohol or drug use (Bennett et al., 2014; Roberts et al., 2011) were consistent predictors of non-attendance to the postpartum visit; however, three of these studies only included Medicaid recipients or only observed the relationship among Medicaid recipients. Only Bennett et al. specified that the tobacco, alcohol, or drug use occurred during pregnancy in their analysis; the

other identified articles did not clarify whether these variables referred to pre-pregnancy use or use concurrent with pregnancy. Masho et al. identified reduced odds of postpartum visit attendance for tobacco users among their cohort of Medicaid recipients in Virginia (aOR 0.84, 95% CI 0.72-0.98). Battarbee and Yee noted a similar trend in their bivariable analysis of their cohort of women with GDM (cOR 0.4, 95% CI 0.2-1.0), but the association between smoking and follow-up was non-significant in their fully adjusted multivariable model (aOR 0.8, 95% CI 0.3-2.5).

Weir et al. had a cohort only drawn from Massachusetts Medicaid users and observed that women with a substance use disorder were less likely to return for a postpartum visit in multivariable analysis (aOR 0.4, 95% CI 0.26-0.62). Bennett et al. included women insured by commercial and Medicaid plans in their study, but after stratifying by insurance status, drug or alcohol use during pregnancy was only a negative predictor of postpartum visit attendance among those insured by Medicaid (aOR 0.71, 95% CI 0.62-0.81).

Because of the stigma associated with substance use during pregnancy, it is likely that rates of tobacco, alcohol, and illicit drug use are underreported. Therefore, these relationships only capture the association between women who report substance use and postpartum visit attendance. This dataset is similarly limited by what the provider indicates in the chart, which is informed by social history the patient gives and, possibly, drug screening tests. The data for tobacco, alcohol, and drug use in this study are similarly limited by what is disclosed in the electronic medical record; however, the data collected are specific to use in pregnancy, whereas many of the other studies did not specify when use occurred.

Education Level

Level of education was less frequently evaluated as a predictor of postpartum visit attendance than other variables, as it was less frequently collected and available in the data sources used by the identified studies. Among those that did measure education, higher levels of education tended to predict higher likelihood of postpartum visit attendance (Baldwin et al., 2018; Bennett et al., 2014; Chen et al., 2019; Morgan et al., 2018). None of the studies using only insurance claims as a data source were able to directly measure education level.

Both Chen et al. and Baldwin et al. collected data on individual educational attainment, which was possible because they used chart review to collect data. Each saw a strong relationship between education and postpartum visit attendance. Because Chen et al. had a highly educated cohort, they were able to compare odds of postpartum visit attendance between those with a high school education or less and those who attended some college, graduated from college, or attended graduate school. The resulting multivariable model found a dose-response relationship between more education and higher likelihood of postpartum visit attendance; when compared with those who graduated high school or less: those who attended some college had 2.45 times the adjusted odds of attendance (95% CI 1.28-4.67), those who graduated college had 5.63 times the adjusted odds of attendance (95% CI 2.63-13.43), and those who attended graduate school had 10.60 times the adjusted odds of attendance (95% CI 3.25-34.62). Because this cohort only included women who planned to postpone another pregnancy for at least a year, and most of the women were privately insured, this relationship may not be generalizable to all women. Baldwin et al. did not include education level in their multivariable analysis, but in bivariable analysis, some college education or more was associated with higher follow-up rates when compared to those with less than some college education: 20% of those who returned within three months for a postpartum visit had less than a college education, compared to 58% of those who did not

return postpartum. This is another cohort that has limited generalizability, because it was only made up of women participating in an IUD clinical trial.

Morgan, Hughes, Belcher, and Holmes (2018) conducted a retrospective analysis of data from the 2012-2013 Pregnancy Risk Assessment Monitoring System (PRAMS) survey in Maryland to identify predictors of postpartum visit attendance. The PRAMS survey uses a cross-sectional design with stratified random sampling methodology. Women who gave birth were identified through state live birth certificate files and mailed a letter and initial questionnaire 2-4 months after delivery. Completed surveys that were returned were linked to data from birth certificate files. To account for oversampling, non-response, and non-coverage, data are weighted. Postpartum visit attendance was measured through a survey question that asked: “Since your new baby was born, have you had a postpartum check-up for yourself?”, to which women could answer “yes” or “no”. A total of 46 women did not respond to this question and were excluded, yielding a final sample size of 2,204 women. The women in the sample were mainly non-Hispanic white or black (44.1% and 30.6%, respectively) and had more than a high school education (68.2%). A large portion, 43.3%, reported receiving food through the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) program. In the multivariable model, having education beyond high school was associated with higher odds of attendance (aOR 1.89, 95% CI 1.05-3.33) after controlling for race/ethnicity, marital status, fetal death, dental care in the year before pregnancy, pregnancy intendedness, health insurance, PNC utilization, and whether the mother worked during pregnancy, supporting the findings of Chen et al. and Baldwin et al. The biggest limitation for this research is that postpartum visit attendance was self-reported, so the data may have been influenced by reporting and social desirability biases. Because the PRAMS survey uses weighting, the other limitations of using a survey

design, like non-response bias, are minimized. As this dataset does not contain information on educational achievement, I am unable to evaluate the impact of education on postpartum visit attendance among the cohort.

Annual Income Level

Because the limitations of measuring income are similar to those encountered with measuring education level, few studies analyzed the impact of income on postpartum visit attendance. Among those that did, two observed that women with lower income levels had a lower likelihood of postpartum visit attendance (Baldwin et al., 2018; DiBari et al., 2014). DiBari et al. measured income in their mailed survey sent to 10,000 women who delivered in Los Angeles. Women who reported a family income under $20,000 annually had approximately one-third the odds of reporting attendance to the postpartum visit (aOR 0.35, 95% CI 0.17-0.70). Because of the covariance between insurance status and income, DiBari et al. created two separate models for multivariable analysis: one including income and excluding insurance status, and one excluding income and including insurance status. This association between income and insurance status may also explain why few studies measured income level, as insurance status is an easier variable to ascertain from insurance claims or electronic medical records. Baldwin et al. was the other investigation that identified a relationship between lower income and postpartum visit non-attendance. They, however, compared income levels below and above $50,000 annual income; those making less than $50,000 per year made up 45% of those who attended the postpartum visit, compared to 91% of those who did not attend the postpartum visit. As with education, income was not included in the multivariable analysis done by Baldwin et al., and the same limitations apply due to only including clinical trial participants in the cohort.

Diabetes Postpartum Screening

Besides the traditional postpartum visit and BP checks, as of 2018, ACOG recommends postpartum screening 4-12 weeks postpartum with a 2-hour oral glucose tolerance test (OGTT) for women diagnosed with GDM (ACOG, 2018). Previously, the fasting plasma glucose test has also been used for diagnosing diabetes in the postpartum period. Attendance predictors to this visit may be relevant for this study, as postpartum glucose screening is similar to BP screening because they both are disease-specific visits that are in addition to, but usually distinct from, the traditional postpartum visit. There are important distinctions that limit relevance, particularly that the screening glucose tests take longer than a BP check, and occur later in the postpartum period than the BP check that occurs at one week.

A review of the literature for articles examining diabetes screening attendance predictors in the postpartum period yielded four main articles: Battarbee and Yee and Ehrenthal et al., both of which have been discussed in the context of their findings on postpartum visit attendance, Nielsen, Kapur, Damm, de Courten, and Bygbjerg (2014), and Stasenko et al. (2010). Many of the initially identified articles were included in the Nielsen et al. systematic review, so I will not separately discuss all of them to avoid redundancy. Looking at the studies individually, the predictors of follow-up diabetes testing are generally similar to predictors of postpartum care attendance, with testing promoters including older age, nulliparity, higher income, higher education, and prenatal care use (Tovar, Chasan-Taber, Eggleston, & Oken, 2011). Yet, Nielsen et al. examined the entire body of literature together, and found that predictors are inconsistent, with few variables consistently identified across the literature. The only variable identified as

predicting increased diabetes screening follow-up was attending a postpartum visit with an OB/GYN.

The systematic review from Nielsen et al. included articles published prior to September 2012 that reported on postpartum screening among women with GDM. The search was performed with PubMed and excluded non-English language articles, but did not exclude research that was based outside of the U.S. They identified thirty-six articles that evaluated rates and results of postpartum diabetes screening and fit their criteria. This includes several studies using qualitative or mixed methods research designs, so not all thirty-six had relevant information on predictors of postpartum screening. Most came from the U.S. (19 articles), but other countries represented included Australia (9), Canada (6), Denmark (1) and The Netherlands (1). Looking across the potential predictors of postpartum diabetes screening, for most there was at least one article that identified that variable as a predictor of postpartum screening; however, the direction of the relationship was either inconsistent across the articles, or the majority of the others found null results. The only exception identified was that women who attended a postpartum visit with an OB/GYN were more likely to be screened for diabetes postpartum.

Among the articles included in the Nielsen et al. review, none reporting demographic or clinical correlates of postpartum screening took place in the Southeast, which would have been the most relevant to this study. In the absence of data from the Southeast, the next most relevant sample would be one including women who reside nationwide. Blatt, Nakamoto, and Kaufman (2011) used data from Quest Diagnostics, which provides laboratory services nationwide, to determine characteristics of women who attend postpartum diabetes screening. Among the 23,299 women who used Quest Diagnostics for laboratory care postpartum, 4,486 returned for postpartum diabetes screening within six months. Because of the limited data available from laboratory

records, delivery date and the six month postpartum cut-off were determined by estimating the first GDM screening test to occur at a gestational age of 24 weeks. The authors observed the highest rate of postpartum screening among Asian women (19.1% screened) and the lowest among white women (14.8% screened). Asian race was also a positive predictor of postpartum visit attendance identified by Battarbee and Yee, suggesting some similarities between the postpartum visit and postpartum diabetes screening predictors. Yet, white race tended to positively predict postpartum visit attendance, while these results show the opposite for GDM screening. Older age was also identified as a predictor of postpartum diabetes screening, mirroring the trend seen for postpartum visit attendance. There are several limitations to this analysis, particularly that demographic and clinical characteristics other than age and race/ethnicity were not available, and that no multivariable analysis was performed. Additionally, to be included in the sample, women had to have used Quest Diagnostics at some point during or after their pregnancy, perhaps creating a cohort disproportionately adherent to medical care. Yet, this study provides a look at trends across the U.S. in a nationally representative sample (in regards to age and race/ethnicity).

Ehrenthal et al. found predictors of OGTT screening visit attendance among the subset of their cohort with GDM that were similar to postpartum visit predictors generally: private insurance (aOR 5.0, 95% CI 1.6-14.9) and at least a high school level of health literacy (aOR 13.2, 95% CI 1.5-120.2) were associated with greater follow-up rates. As the sample only included women who attended the three month postpartum study visit and used self-report attendance data, these findings are limited. Battarbee and Yee identified contrasting results, finding that Medicaid insurance, non-English speaking, tobacco use, and late utilization of PNC were associated with a greater likelihood of screening attendance. This is particularly surprising because Medicaid

insurance and late presentation to PNC were associated with lower rates of follow-up among their cohort for the traditional postpartum visit. However, these findings are limited because they only assessed OGTT completion rates among those who also completed a traditional postpartum visit. Therefore, they may be leaving out the most vulnerable and least adherent subset of their sample.

Stasenko et al. conducted a retrospective cohort study of women with GDM who delivered at the University of California, San Francisco medical center between 2002-2008 (n=745). Data were abstracted from the medical records, and laboratory records were also used. Patients were considered to have been screened if they had postpartum testing with OGTT or fasting plasma glucose within six months of delivery. In the fully adjusted model, Asian race was associated with postpartum testing follow-up when compared to white women (aOR 2.88, 95% CI 1.57-4.74). Other predictors of postpartum diabetes testing included age 35 or older (aOR 1.62, 95% CI 1.03-2.56), nulliparity (aOR 1.66, 95% CI 1.06-2.58), and GDM subtype A2 (GDM controlled with insulin, as compared to controlled by diet/exercise) (aOR 2.28, 95% CI 1.43-3.63). This model controlled for race/ethnicity, age, parity, pregestational BMI, insurance status, and education. All continuous and ordinal variables were dichotomized for the analysis, including age, antenatal BMI, education, and number of prenatal care visits, which may have obscured important predictors. For example, maternal education was compared between those who attended less than two years of college and more than two years of college. For postpartum visit predictors, education and attendance had a dose-response relationship, with the most educated women being the most likely to attend a postpartum visit. By creating a dichotomy in education, such a dose-response relationship may not be evident, if it exists.

When examining individual studies, predictors of postpartum GTT screening mostly mirror predictors of postpartum visit attendance. Yet, when the bigger picture is examined by looking at the entire body of literature, most variables are inconsistent predictors, with the majority of studies finding null results for their relationship with diabetes screening. However, although not many variables may consistently predict screening across different cultural contexts, ignoring the relationships that are observed in some studies may obscure regional or sub-population trends. None of the identified articles were conducted in the Southeast, where this study was located. One article examined trends in a national sample, which identified Asian race and older age as predictors of postpartum diabetes screening, while white race was associated with lower likelihood of screening (Blatt et al., 2011).

The similarities between predictors of postpartum diabetes screening and the traditional postpartum visit, when they are observed, suggest that attendance at the BP check may also have similar predictors. If identified predictors for this cohort differ significantly, it may be a sign that increasing attendance at the BP check will require different strategies than are used to promote attendance at other postpartum visits.

Summary of current problem and study relevance

While there is little in the literature specific to the BP check visit, the studies that examine predictors of attending the traditional postpartum visit and the postpartum diabetes screening visit can provide guidance on what variables are important to examine in multivariate analysis. Among the variables for which data is available, the most frequently referenced predictors of postpartum follow-up are race/ethnicity, age, insurance status, PNC utilization, and parity. Understanding how predictors of follow-up BP testing are similar or different from those that

predict six-week postpartum visit or GDM screening attendance is important in identifying barriers or promoters to attendance that may differ between postpartum visit types and in tailoring approaches to improve follow-up rates.

This study fills an important gap in understanding how clinical and demographic characteristics predict likelihood of attending a BP check follow-up visit one week postpartum for women with HDP. Currently, one abstract provides the only published data on predicitors of postpartum BP check attendance. Beyond this, the only other research does not distinguish the BP check visit from the traditional, six-week postpartum visit, potentially yielding inflated attendance rates. This research will offer an estimate of BP check visit attendance that occurs within the first three weeks postpartum, which is a time of higher risk of HDP complications as compared to six weeks postpartum among a high-risk, safety-net population in the Southeast (B. N. J. Walters & Walters, 1987).

Methodology

The purpose of this project was to identify the clinical and demographic characteristics that differed between women who did and did not attend a postpartum BP screening among a high-risk population in the Southeast. We conducted a retrospective, population-based cohort study of pregnant women who delivered at Grady Memorial Hospital (GMH) in downtown Atlanta between July 1, 2016 and June 30, 2018. Women were included if their delivery was supervised by an Emory University physician and if they delivered one or more fetuses past twenty weeks of gestation. We collected data on demographic and clinical characteristics of each participant through manual chart abstraction. Following data collection, I performed bivariable and multivariable analyses to identify predictors of postpartum BP screening attendance.

Population and Sample

The sample was drawn from women who delivered at GMH over a two-year period between July 1, 2016 and June 30, 2018 who were supervised by an Emory University physician. The research team identified deliveries were identified using Emory billing charges and cross-referenced this list with the Labor and Delivery unit records. As GMH is staffed by physicians from Emory University and Morehouse Healthcare, not all deliveries were captured during the study period, but as Emory University physicians supervise approximately 70% of deliveries, most deliveries were included. Women were included if they delivered one or more fetuses after 20 weeks of gestation, even if the fetuses were not viable.

The Grady Health System is a large, academic, public healthcare system, with GMH located in downtown Atlanta. The Fulton-DeKalb Hospital Authority, which owns Grady Health System,

was established in part to care for the indigent sick who live in Fulton and DeKalb counties ("FULTON-DEKALB HOSPITAL AUTHORITY - GRADY HEALTH SYSTEM," 2020). Pursuant to that mission, GMH primarily serves a vulnerable and underserved population living in DeKalb and Fulton counties, most of whom are insured publicly (Medicare or Medicaid) or are uninsured ("Grady Memorial Hospital," 2018).

Grady Memorial Hospital was selected as the study setting because of the high prevalence of HDP. For this investigation, GMH is an ideal setting because several characteristics of the population it serves are associated with a higher risk of developing HDP. GMH is situated in the Southeast of the U.S., where rates of HDP are the highest in the country (Fingar et al., 2017). As the population GMH serves is largely non-Hispanic black and rates of preexisting chronic conditions are high, women at GMH are more likely to develop HDP and to develop severe complications from HDP (Kuklina et al., 2009; Zhang et al., 2003). Attending a BP screening visit may be most beneficial for those at highest risk of developing HDP and subsequent complications, so understanding clinical and demographic characteristics of patients who attended the BP screening visit may be most impactful in a setting like GMH.

Research Design

This project employed a quantitative, analytic research design and aimed to identify demographic and clinical characteristics associated with postpartum BP screening attendance that may inform future research and interventions.

Procedures

Two sources were used to identify deliveries during the study period for inclusion in the study. First, data on billing charges were collected from the Emory Medical Care Foundation Database, which contains billing data from Emory University clinicians. Additionally, the record kept in the Labor and Delivery unit at GMH was consulted to confirm that all eligible deliveries were captured. Once the preliminary list of deliveries was compiled, each was checked in the electronic health record to confirm eligibility, which was primarily ensuring the delivery occurred after 20 weeks gestation.

Once the cohort was established, abstractors were trained on standardized data collection practices using the collection instruments, which were housed on the Research Electronic Data Capture (REDCap) tools hosted at Emory University.

Instruments

Abstracters collected data using two instruments, one that captured general demographic information, clinical data, and obstetric outcomes, and another that focused on HDP-related data. Collaborators from the Emory School of Medicine Obstetrics & Gynecology Department assisted in training abstracters on how to gather the needed information from the electronic medical record (EMR) used by Grady Health System, which uses Epic software. Because each woman's pregnancy, delivery, and postpartum experience was different, the information for abstraction was sometimes found in different places in the EMR. Therefore, abstractors used a combination of PNC notes, laboratory results, history & physical (H&P) notes, discharge summaries, and other assorted records to gather data. The data fields included in this instrument were based on a review of the literature and clinical expertise.

The HDP-specific instrument included information on HDP diagnoses, clinical course, medical interventions, and postpartum outcomes. HDP diagnoses were defined using ACOG definitions (ACOG Task Force on Hypertension in Pregnancy, 2013). For those who were diagnosed with at least one of the HDP, abstracters recorded gestational age or days postpartum at which diagnoses were made. Additionally, abstracters collected data on any clinical interventions used, including magnesium sulfate prophylaxis use, intravenous hypertensive drug use, and prescription of BP medications. Abstractors recorded information on postpartum outcomes, including attendance at a BP check within three weeks of delivery and whether BP was elevated at that check. In order to capture all visits at which BP was measured, abstracters recorded whether any visit, including both outpatient and inpatients visits, within three weeks occurred and the reason for the visit. If patients returned multiple times within the first three weeks, only the reason for the first visit was recorded. Visits that occurred within three weeks were categorized as: (1) visits specifically for a BP check, (2) visits related to HDP complications, (3) visits for complications not related to HDP, and (4) other. The other category primarily captured inpatient visits. The instrument also included whether women were readmitted to the hospital, timing of readmissions, and readmission indication (HDP related or not).

Plans for Data Analysis

Once the data were collected, I created a new dataset including only the women in the original cohort who had been diagnosed with any of the HDP, including chronic hypertension, preeclampsia with or without severe features, super-imposed preeclampsia, gestational hypertension, and preeclampsia complicated by eclampsia and/or HELLP syndrome. As some women had multiple HDP diagnoses, I then created mutually exclusive categories and

categorized women by their most severe diagnosis. I designated preeclampsia complicated by eclampsia or HELLP syndrome as the most severe, followed super-imposed preeclampsia, preeclampsia with severe features, preeclampsia without severe features, gestational hypertension, and chronic hypertension. As gestational hypertension can only be diagnosed in women without chronic hypertension, no woman would have been diagnosed with both, so one was not considered more severe than the other. Because HDP can develop during pregnancy and postpartum, some women were diagnosed with HDP after they had left the hospital following delivery. For these women, a BP check would not have been recommended at the time of hospital discharge, because no HDP had developed yet. Therefore, women who received their first diagnosis of any of the HDP after three days postpartum were excluded from the analysis. Three days postpartum was selected as the cut-off point because women with hypertensive disorders are regularly hospitalized until 72 hours post-delivery.

While ACOG recommends that BP checks occur approximately one week after delivery, this study aimed to capture all BP checks that occurred, even if they fell outside the recommended timeframe. Therefore, any BP checks that occurred within three weeks of delivery were included in this study. Women with HDP who attended any kind of healthcare visit within three weeks postpartum during which their BP was measured were categorized based on the purpose for their first visit. Women who returned specifically for a BP check were considered to have attended the BP check, which was the main outcome of interest. Women who did not attend any kind of visit within three weeks postpartum were considered to have not attended the BP check. Women who returned for other reasons, including visits for complications of HDP and visits unrelated to HDP, were excluded from the analysis. Additionally, those whose reason for their visit within three-weeks were classified as “other” were excluded from all analyses, as this category mainly

included women who were still inpatient a week after their deliveries, and therefore, whether or not they returned for a visit is not an applicable question.

Before calculating descriptive statistics, I cleaned and reorganized some of the included variables. The continuous variables maternal age, gestational age at delivery, and parity were categorized, with the categories informed by the literature review. When individual cell size was under ten, I reorganized variables to create categories with more robust cell sizes. Specifically, I categorized non-Hispanic women who were not white or black in a non-Hispanic other category. Additionally, I recoded insurance status to group together Medicaid and Medicare recipients in a Medicaid/Medicare group. Alcohol use during pregnancy, cardiovascular disease during pregnancy, and HIV infection during pregnancy also had individual cells smaller than ten, but there was no reorganization strategy that was appropriate, so they were not changed.

PNC utilization was categorized based upon the Kotelchuck index, which defines PNC utilization as adequate plus, adequate, intermediate, or inadequate based on gestational age of PNC initiation and number of PNC visits (Kotelchuck, 1994). If women sought any of their PNC outside of Grady, their PNC utilization was considered transfer of care or unknown, and they were not categorized with the Kotelchuck index. The PNC provider variable was also recoded, as women sometimes saw more than one type of provider. To create mutually exclusive categories, women were grouped by the most specialized provider that they saw. For this, high-risk OB/GYN physicians were considered the most specialized, followed by OB/GYNs, centering groups, and finally, Certified Nurse Midwifes (CNMs) or Physician Assistants (PAs). For variables with missing values, those values were excluded from analysis and number missing were noted (Table 1). Because PNC provider was frequently missing, unknown/missing values were included as their own subcategory in bivariable analysis.

After these steps were taken, I calculated descriptive statistics of demographic and clinical characteristics for the entire sample of women with HDP and stratified by attendance at the BP check. For each variable, I used a chi-square test of association (alpha = 0.05) comparing women who attended the BP check to those that did not to determine statistical significance.

Before conducting multivariable analysis, I recoded variables that had cell sizes smaller than 15. For specific HDP diagnosis, I categorized preeclampsia complicated by eclampsia or HELLP with preeclampsia with severe features. For race/ethnicity, I excluded those whose race was listed as unknown from analysis. Additionally, I categorized together non-Hispanic white and non-Hispanic other women.

I determined which variables to include in the model a priori based upon the literature review. After examining results of the bivariable analysis, I did not add any additional variables to the model. I modelled attendance at the BP check visit using a log binomial regression model which included the variables race/ethnicity, HDP diagnosis, age, insurance status, PNC utilization index (Kotelchuck index), parity, and mode of delivery. I estimated crude (cRR) and adjusted risk-ratios (aRR) for all the variables included in the log binomial regression model, as well as 95% confidence intervals (CIs) for each estimate.

For the sensitivity analysis, I considered all women who attended any visit within three weeks of delivery to have attended the BP check. I then recreated the same multivariable model using the new definition of attendance as the outcome, and estimated the crude and adjusted risk-ratios, as well as 95% CIs for all the variables. All analyses were performed using Statistical Analysis Software (SAS Institute Inc., Cary, NC), version 9.4.

Ethical Considerations

This study was approved by the Institutional Review Board at Emory University and the Grady Research Oversight Committee.

Results

Sample Characteristics

A total of 1,360 deliveries were complicated by HDP diagnosed either during pregnancy or within three days postpartum. After excluding women who returned for visits related to medical complications that were not BP checks, 1262 deliveries were included in the analyses. Women in the sample were predominantly non-Hispanic black (80.8%), insured by Medicaid/Medicare (89.0%), had a parity of two or more (63.5%), and had less than adequate PNC utilization (54.7%). When categorized by each delivery's most severe diagnosis, nearly half (46.1%, n=582) of deliveries were only complicated by gestational hypertension. The rest were complicated by chronic hypertension only (17.8%, n=224), preeclampsia with severe features (14.3%, n=180), preeclampsia without severe features (13.0%, n=164), chronic hypertension with superimposed preeclampsia (7.3%, n=92), or preeclampsia complicated by HELLP syndrome and/or eclampsia (1.6%, n=20).

Bivariable Analysis

Only 23.8% of women returned for a BP check within three weeks postpartum (n=300). In bivariable analysis, the strongest predictors of BP check attendance were HDP diagnosis, discharge with BP medication, race/ethnicity, mode of delivery, parity, GDM, DM, PNC utilization index, and PNC provider (Table 1). Characteristics that were indicative of more complicated pregnancies tended to predict higher likelihood of attendance at the BP check visit; preeclampsia with severe features, prescription of BP medication, Cesarean delivery, GDM, DM, and PNC provided by a high-risk obstetrician all were associated with higher follow-up rates.

Black and Hispanic women tended to follow-up less frequently than white women, and women with higher parity and lower rates of PNC utilization were also less likely to attend BP check follow-up.

Preeclampsia with severe features was the strongest positive predictor of BP check attendance: 22.3% of those who attended the BP check had a diagnosis of preeclampsia with severe features, compared to only 11.8% of those who did not attend. Gestational hypertension had the opposite effect, as only 37.3% of those who attended the BP check were diagnosed with gestational hypertension, compared to nearly half (48.9%) of those who did not attend the BP check. When preeclampsia with severe features was compared to gestational hypertension, those with preeclampsia with severe features were more than twice as likely to attend the BP check (cRR 2.67, 95% CI 1.88-3.81). Eclampsia and HELLP Syndrome diagnoses were rare in this cohort, so for the purposes of this analysis, I did not separate them out from other cases of preeclampsia with severe features when calculating this cRR.

PNC utilization, quantified using the Kotelchuck index, had a clear dose-response relationship with postpartum BP screening attendance in bivariable analysis. Those with inadequate PNC utilization made up 44.3% of those who did not attend the BP check, but only 32.8% of those who did attend the BP check. In contrast, women whose PNC was categorized as adequate plus made up 18.1% of those who did attend the BP check and only 8.6% of those who did not. When compared to those with adequate plus PNC utilization in bivariable analysis, all other categories were significantly less likely to attend the BP check, and the relationship was strongest for women with inadequate PNC (cRR 0.34, 95% CI 0.23-0.51).

Nulliparity or primiparity was associated with higher rates of postpartum BP check attendance while pre-pregnancy parity of two or more was associated with lower attendance rates. Unlike

PNC utilization, attendance did not increase incrementally with changes in parity; instead, those with a parity of one or less had a similar likelihood of follow-up and women with a parity of two or more had a similar likelihood of follow-up. When primiparous women were compared to nulliparous women, their unadjusted likelihood of attendance at the BP check was the same (cRR 1.04, 95% CI 0.67-1.63). When women with a parity of two and three or more were compared with women who were nulliparous before the index pregnancy, both groups had a 37% lower likelihood of attendance at the BP check (parity of 2: cRR 0.63, 95% CI 0.43-0.94; parity of three or more: cRR 0.63, 95% CI 0.46-0.87).

Race/ethnicity was another important predictor of BP visit attendance. Non-Hispanic white women, who made up a small overall proportion of the sample (3.0%), made up 5.4% of all women who attended the BP check and only 2.2% of those who did not attend this visit. Similarly, non-Hispanic women of other race made up 3.7% of those who did attend the BP check and only 1.8% of those who did not. Non-Hispanic black women, in contrast, made up a larger proportion of those who did not attend the BP check than those who did. Non-Hispanic black women made up 83.1% of non-attendees for the BP screening visit and 73.6% of attendees; in comparison with non-Hispanic white/other women, non-Hispanic black women were less than half as likely to attend the BP check visit (cRR 0.39, 95% CI 0.23-0.66). The relationship was not as strong for Hispanic ethnicity, but Hispanic women were still 40% less likely to attend a visit when compared with non-Hispanic white/other women (cRR 0.60, 95% CI 0.33-1.07).

Finally, mode of delivery had a clear impact on postpartum BP check attendance. While women who had a Cesarean delivery made up a little less than half (45.3%) of those who attended the BP check, they made up less than a third (30.3%) of those who did not attend the BP check.

When compared to women who delivered vaginally, women who had a Cesarean delivery were almost twice as likely to attend a BP check (cRR 1.90, 95% CI 1.46-2.48).

Multivariable Analysis

In order to identify how demographic and clinical characteristics independently alter likelihood of attending a postpartum BP check, I modelled attendance with a log binomial regression model adjusted for HDP diagnosis, race/ethnicity, age, insurance, PNC utilization index, parity, and mode of delivery (Table 2). Of the 1262 deliveries identified for bivariable analysis, 18 were excluded because they were missing values for one or more of the variables included in the model, resulting in a sample size of 1244 for multivariable analysis.

As in bivariable analysis, more severe HDP diagnoses was associated with higher rates of attendance at the BP check visit. Because of the low number of women with HELLP syndrome and eclampsia, these diagnoses were included in a category with women with preeclampsia with severe features. When this group was compared to women with gestational hypertension, women with preeclampsia with severe features had more than twice the likelihood of returning for the BP check (aRR 2.29, 95% CI 1.57-3.33). Those with preeclampsia super-imposed on chronic hypertension (aRR 1.32 95% CI 0.77-2.27) had an elevated likelihood of attending the postpartum visit when compared to women with gestational hypertension, as did women with preeclampsia without severe features (aRR 1.25, 95% CI 0.81-1.92).

Prenatal care utilization also had a dose-response relationship with BP check attendance. Despite the model being adjusted for several characteristics, the crude and adjusted RRs for each category of PNC utilization differed very little. Those with inadequate PNC had approximately

one-third the likelihood of attending a BP check as did those with adequate plus PNC (aRR 0.32, 95% CI 0.20-0.50). Also less likely to attend a BP visit when compared to women with adequate plus PNC were women whose PNC utilization was categorized as intermediate (aRR 0.37, 95% CI 0.21-0.64) or adequate (aRR 0.60, 95% CI 0.37-0.98).

After adjusting for other characteristics, parity remained a predictor of postpartum BP screening. Nulliparous women were the most likely to attend their BP follow-up visit, and women with a parity of two or more were significantly less likely to attend follow-up in comparison. Women with a parity of two (aRR 0.58, 95% CI 0.37-0.89) and women with a parity of three or more (aRR 0.63, 95% CI 0.43-0.93) both had a similarly reduced likelihood of BP check attendance when compared with nulliparous women. Primiparous women who were primiparous had a slightly lower likelihood of follow-up attendance (aRR 0.91, 95% CI 0.56-1.48).

For analysis of the impact of race/ethnicity, non-Hispanic white and non-Hispanic other women were combined into one group and compared with non-Hispanic black women and with Hispanic women. Non-Hispanic black women had a 50% lower likelihood of attending a postpartum BP check when compared to non-Hispanic white/other women (aRR 0.50, 95% CI 0.28-0.88). Hispanic women also had a reduced likelihood of BP check attendance when compared with non-Hispanic white/other women, but the relationship was not as strong as for non-Hispanic black women (aRR 0.67, 95% CI 0.35-1.29).

As in bivariable analysis, mode of delivery had a strong association with postpartum BP check attendance. Women who had Cesarean deliveries had a greater likelihood of attending a postpartum BP screening visit when compared to those who delivered vaginally (aRR 1.61, 95% CI 1.21-2.15). Finally, both publicly insured and uninsured women were less likely to attend their postpartum BP check when compared to commercially insured women. Women with

Medicaid/Medicare had a 32% lower likelihood of attendance (aRR 0.68, 95% CI 0.39-1.15) and uninsured women had a 24% lower likelihood of attendance (aRR 0.76, 95% CI 0.34-1.72).

Sensitivity Analysis

For the sensitivity analysis, rather than including only those who returned for a BP check specifically, I included everyone who attended for any kind of visit at which their BP was measured as having attended a visit. I repeated the multivariable analysis using the same variables but this expanded definition of the outcome variable. Therefore, the RRs reflect likelihood of a woman seeking healthcare with Grady Health Systems within three weeks of delivery. When comparing these estimates to the results for the main multivariable analysis, differences between the sensitivity analysis outcomes and the BP check outcomes indicate differences in seeking healthcare mostly for postpartum complication concerns.

When all visit types were included, there were 398 women who returned for a visit within three weeks of delivery, which represents 29.2% of a total sample of 1360 (Table 3). While most visits were for BP checks specifically (75.4%), another 8.5% (n=34) returned for a visit related to HDP and 16.1% (n=64) returned for a visit not related to any HDP complication. For the sensitivity analysis, women with any missing data were excluded (n=20), yielding a sample size of women who returned for a visit was 394 out of 1340 women with complete data.

Including all visits did not dramatically change the results of the bivariable and multivariable analyses, except for strengthening the estimated association between attendance and both chronic hypertension and Cesarean section and weakened the association between attendance and preeclampsia with severe features (Table 4). The largest difference for any variable between the

multivariable analyses was for preeclampsia with severe features. While those with preeclampsia with severe features had approximately 2.3 times the likelihood of attending a BP check than women with gestational hypertension (aRR 2.29, 95% CI 1.57-3.33), that same group was only twice as likely to attend any visit postpartum when compared to those with gestational hypertension (aRR 2.00, 95% CI 1.42-2.82). In contrast, those who delivered via Cesarean section were more likely to attend any postpartum visit (aRR 1.70, 95% CI 1.21-2.15) than they were to specifically attend a BP check (aRR 1.61, 95% CI 1.21-2.15), both when compared to vaginal delivery.

For women with chronic hypertension, they were even less likely to seek any healthcare than they were to return for their BP check. Women with chronic hypertension were 35% less likely than those with gestational hypertension to return for any type of visit within three weeks postpartum (aRR 0.65, 95% CI 0.44-0.96); in contrast, they were only 26% less likely than those with gestational hypertension to return specifically for a BP check visit (aRR 0.74, 95% CI 0.48-1.14).

Discussion

The overall attendance rate at the postpartum BP check within three weeks of delivery was only 23.8% in this high-risk population in the Southeast. Notably, this is less than half the rate of 51% identified by Romagano et al. in their New Jersey-based cohort (Romagano et al., 2020). Current guidelines from ACOG recommend all women with HDP attend a BP check approximately one week after delivery in order to identify postpartum hypertension and its complications early, in an effort to prevent maternal morbidity and mortality (ACOG Task Force on Hypertension in Pregnancy, 2013). Therefore, the finding that less than a quarter of women with HDP attend a BP check is concerning, especially for a cohort that is at high risk for HDP and related complications. Particularly in Georgia, where the maternal mortality ratio is consistently one of the highest in the country, and at GMH where women experience severe maternal morbidity at a disproportionately high rate, preventing morbidity and mortality from postpartum hypertension is crucial (Centers for Disease Control and Prevention, 2019). After examining the clinical and demographic characteristics associated with BP check attendance, the most important variables positively associated with follow-up were high PNC utilization, severe HDP, and Cesarean delivery. Both PNC utilization index and HDP severity had dose-dependent relationships with BP check attendance, suggesting a close link between these variables and likelihood of attendance. The connection between BP check attendance and HDP diagnosis may also indicate a greater perceived importance of the BP check on the part of women or providers who counsel women. While overall attendance was low, it is a positive sign that women with more severe disease were more likely to return for their BP check.

Characteristics negatively associated with attendance at the BP check included non-Hispanic black race/ethnicity, public insurance, and a parity of two or more. This indicates that although return rates for the BP check were low overall, disparities still exist. This is especially true for non-Hispanic black women, who were half as likely to return for their BP check when compared to non-Hispanic white/other women. The differences in attendance by race are likely indicative of the social and structural disparities that permeate through society and healthcare, including racial differences in healthcare quality and access, socioeconomic status, and race-related stress (Jain et al., 2018; Mendez, Hogan, & Culhane, 2013).

The findings of this study support similar results from Romagano et al., including the association between higher postpartum BP check attendance and both severe HDP and Cesarean deliveries, as well as the association between lower attendance and non-Hispanic black race/ethnicity. While these trends were identified in Romagano et al.'s bivariable analysis, this study goes a step further by examining predictors in a multivariable model among a larger cohort. Moreover, the identified predictors of attendance at the postpartum BP check are similar to the commonly cited predictors of postpartum visit attendance in the literature, suggesting there may be similar barriers and facilitators to attendance at the BP check and the traditional postpartum visit.

Yet, both this investigation and the research from Romagano et al. provide insight only on patient characteristics associated with BP check attendance. What these investigations cannot provide is an explanation of the mechanisms that underlie and explain these trends. Therefore, research on healthcare setting and provider influence on BP check attendance is needed, as is an examination of how structural factors contribute to these trends. One qualitative analysis of barriers and facilitators of attendance at the traditional postpartum among low-income women identified a number of provider-related variables that women cited as important (Henderson et

al., 2016). They identified their comfort with providers and staff, appointment reminders, childcare availability, and availability of appointment times around their commitments as important facilitators for postpartum visit attendance. Factors like these may explain why women with a parity of two or higher were less likely to attend a BP check postpartum; a lack of childcare availability may be an important barrier for women with more children. Understanding these factors could yield actionable insight on the barriers women face; for example, if childcare is a barrier, providing childcare during appointments may increase attendance.

Limitations and Strengths

There are several limitations of this study that must be acknowledged. First of all, this study was conducted in a high-risk, largely non-Hispanic black and Medicaid insured population in the Southeast, so the findings may have limited generalizability to populations that differ in demographics or geographic location.

Another significant limitation is how timing of the BP check was measured. This study captured all visits that occurred within three weeks of delivery, so BP checks that occurred within the recommended timeframe (approximately one week postpartum) and BP checks that occurred late cannot be distinguished. BP checks are meant to identify postpartum hypertension before complications causing morbidity and mortality occur, and BP usually peaks 3-6 days postpartum (Walters & Walters, 1987). Therefore, visits that occur after the one-week mark would be too late to capture most postpartum hypertension cases. However, among this cohort, women infrequently rescheduled BP checks, so women who were classified as attending a BP check (as

opposed to returning for complications) probably had that check within the recommended timeframe, as scheduled by their providers.

Abstracting data from the medical records of patients also has inherent limitations. Patient charts are subject to over- and under-coding, as providers may differ in how much and what information they choose to record. Information in medical records are limited to visits the patient had within Grady Health System and therefore care that women may have sought care at other healthcare providers is not included in the data. This may be especially important among this cohort, as all the study subjects had HDP diagnoses, and therefore may have been referred from other health centers for specialized care at Grady. These women may have returned to their original providers for any postpartum care, possibly including a postpartum BP check. Women who transferred care to Grady for PNC at some point in their pregnancy were the least likely to return for a BP check when compared to women who sought PNC at Grady, which supports the possibility that they sought any care from their original providers outside of the Grady Health System. Because of this limitation, women who transferred care during the prenatal period were categorized separately for the PNC utilization variable.

In addition to not having information on outside visits, collecting data through medical records limited the variables available for inclusion. Specifically, abstracters could not collect data on education status or income, both of which have been identified as predictors of postpartum visit attendance (Chen, Hsia, Hou, Wilson, & Creinin, 2019; DiBari, Yu, Chao, & Lu, 2014; Morgan, Hughes, Belcher, & Holmes, 2018). These variables would have ideally been included because they may be influencing some of the observed relationships. For example, annual income likely affects insurance status, so it is not clear how much of the observed relationship between

insurance status and attendance is truly due to insurance status and how much is better explained by annual income.

Despite the limitations of this study, it has important strengths as well. This study offers the first multivariable model examining demographic and clinical characteristics associated with postpartum BP check attendance. The cohort examined is a high-risk population, with high rates of comorbidities, receiving care at a safety-net institution, and therefore this study provides insight on BP check attendance and predictors of attendance among an especially vulnerable population that would hypothetically most benefit from postpartum BP checks.

Additionally, the use of medical record abstraction allowed analysis of a number of variables that often cannot be determined when using data from insurance claims, including parity and specific clinical diagnoses. The abstraction for details on HDP diagnosis and interventions was more extensive that would have otherwise been possible, yielding detailed data.

Conclusion

This research indicates that among a high-risk population who have HDP, the majority of women are not getting their BP screened within three weeks postpartum. The population from which this study was drawn is a mostly non-Hispanic black, low-income group utilizing a safety-net institution for care. While the study findings indicate that women with more severe HDP diagnoses were more likely to return for their BP checks, there were important disparities by race, insurance status, and parity. Even among the demographic group most likely to attend, non-Hispanic white women, return rate for the BP check was only 43.2%.

More research is needed to understand the barriers and facilitators of BP check attendance both specific to the patient and to the healthcare setting. Quantitative and qualitative investigations of how social factors, like transportation and childcare access, influence likelihood of visit attendance would be beneficial for determining what types of interventions would be most effective in improving BP check attendance. Additionally, research on provider and setting characteristics, like flexibility of appointment scheduling, consistency of provider, and provider type may also highlight important determinants of postpartum attendance that are missed in patient-focused investigations like this one.

Barriers to postpartum BP check attendance may be too difficult to overcome in populations like this one, so alternate approaches to postpartum BP screening and management are needed in addition to more research. Clinical interventions such as home BP monitors or home screening visits may be effective alternatives to the BP check, especially among women who face significant barriers to accessing postpartum care. Another alternative may be incorporating BP screening at newborn well-child visits, which women may be more likely to attend.

This study is an important step in better understanding attendance patterns for the postpartum BP check. High attendance among women at this visit has the potential to reduce the burden of severe maternal morbidity and mortality caused or exacerbated by HDP. Yet, the findings of this study suggest that we have a long way to go in improving BP check attendance. Addressing the gap in postpartum BP screening will require additional research and creative solutions to address barriers at the individual-, provider-, and system-levels.

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Tables and Figures

Table 1. Literature review summary: predictors of postpartum visit and screening attendance, organized by outcome measured.						
Reference	Study Population	Design/data source	Outcome(s)	Facilitators	Barriers	Limitations
BP screening						
Romagano et al. (2020) [abstract]	n=378, women diagnosed with HDP between March-August 2017 and March-August 2018 in an academic, urban healthcare facility in New Jersey	Retrospective cohort study of women from an intervention study on warning signs; data were abstracted from electronic medical record	Clinic visit 3-10 days post-delivery for BP evaluation*	Older age, earlier gestational age at delivery, preeclampsia, severe features, cesarean section, antihypertensive medication use, magnesium sulfate prophylaxis, ED visit for HDP postpartum, furosemide postpartum	Non-Hispanic black, gestational hypertension diagnosis	Derived from a study requiring post-birth warning sign instructions be provided, potentially altering follow-up rates; only bivariable analysis available
Postpartum visit attendance only						
Levine et al. (2016)	n=193, women diagnosed with preeclampsia with severe features who delivered between July 2011-February 2013 at a large, academic hospital in Pennsylvania; mostly African American (>75%)	Planned secondary analysis of a retrospective cohort study; data collected through medical record abstraction	Six-week postpartum visit attendance*	Women with chronic DM, cesarean section	Under 30 years old, African American race, <5 PNC visits	Sample size fixed from the parent study, possibly making it underpowered. Data quality limited by quality and completeness of electronic

						medical record data.
DiBari et al. (2014)	n=4075, Women who gave birth in Los Angeles County in 2007. Predominately Hispanic and low-income (<$20,000 annually). Part of the Los Angeles Mommy and Baby (LAMB) study	Cross-sectional, population-based study using a mailed survey (sent 10,000 surveys out). Returned surveys linked to birth certificate data.	Reported postpartum visit attendance	Hispanic, older age, high income (>$100,000 annually), married, private insurance	Non-Hispanic White, low income (<$20,000 annually), no PNC, Medi-Cal insurance	Self-reported attendance, potential non-response and social desirability biases.
Ortiz et al. (2016)	n=97, women with GDM who received postpartum care at a large, tertiary medical center in New Mexico 2012; Largely Hispanic (60%) and American Indian (16%) women, many uninsured (43%)	Retrospective review of medical records for women who were diagnosed with GDM at the study facility	Documented postpartum visit at the hospital*	Non-Hispanic white, private insurance		Small sample size. Data quality limited by quality and completeness of electronic medical record data.
Weir et al. (2011)	n=1,882, Medicaid patients in Massachusetts who delivered between November 6, 2005 and November 6, 2006	Retrospective analysis of Medicaid insurance claims data from a MassHealth managed care population. Data from Healthcare Effectiveness Data and Information Set	A postpartum care visit on or between 21-56 days post delivery	Women with at least five ambulatory care visits in the year before delivery	Age under 20, disabled, substance use disorder, having two or three children in the household	Some variables and data limited: large amount of missing data on race/ethnicity, parity estimated from number of children in the home, no information on

		(HEDIS), linked to MassHealth enrollment and claims data.				type of disability. May only be generalizable to similar, Medicaid populations.
Masho et al. (2018)	n=25,692, Medicaid recipients with singleton live births from 2008-2012 insured by a Managed Care Organization (MCO) in Virginia; the majority were White (56%) and had a high school education only (51%)	Retrospective, cross-sectional analysis of claims data from an MCO that manages Medicaid enrollees in Virginia	Routine postpartum visit code documentation between 3 and 8 weeks postpartum	Black or "other" race/ethnicity, pregnancy complications	No PNC, tobacco use	Medical claims data limited in availability and accuracy: substance use measures may be underreported, PNC utilization limited to yes/no. Only includes Medicaid patients from one MCO.
Chen et al. (2019)	n=512, Women were enrolled between December 2014 to November 2015 who planned to deliver at UC Davis Medical Center, return there for postpartum care, and delay any subsequent pregnancies for at least one year. Majority White (66%) and educated (>75% attended some college or more), privately insured	Secondary analysis of a quasi-experimental study. Data were collected through chart review and a follow-up phone interview 3 and 6 months postpartum	Postpartum visit within 12 weeks of delivery	Over 30 years old, higher education level, history of miscarriage	Parity of 3 or higher, high-risk index pregnancy	Low risk and homogenous cohort that may not be applicable to other populations. Only included women planning to delay next pregnancy by at least one year. Data quality limited by quality and completeness of electronic medical records.

Baldwin, Hart, & Rodriguez (2018)	n=197, Women intending to have an IUD inserted postpartum who delivered at a medical center in Portland, OR enrolled in a clinical trial between February 2012-December 2013. Mostly non-Hispanic (86%) women and women with more than a high school education (73%)	Planned secondary analysis of a randomized control trial of patients planning on using an IUD post-delivery	Postpartum care visit within 3 months of delivery	Private insurance, PNC initiation before 14 weeks of gestation		Sample is entirely women participating in clinical research, who were also compensated for returning for a postpartum visit, limiting generalizability. Data quality limited by quality and completeness of electronic medical record data.
Wilcox, Levi, & Garrett (2016)	n=3,441, women who delivered at either of two Montefiore hospitals in New York in 2013. Mostly Black and multiracial	Retrospective cohort of deliveries, data drawn from an electronic records system with clinical and demographic information	Postpartum follow-up visit within 12 weeks of delivery	Over than 30 years old	Under 20 years old, Hispanic ethnicity, Medicaid insurance or uninsured, vaginal delivery	Excluded women (n=608) who declined to report race/ethnicity. Missing data for gestational age, parity, and education level caused these variables to be excluded from analysis. Data quality limited by quality and completeness of electronic medical record data.

Thiel de Bocanegra et al. (2017)	n=199,860, women continuously enrolled in Medi-Cal who delivered in 2012. Mostly Hispanic and only half spoke English	Prospective cohort study using data from Medi-Cal claims and database	Postpartum visit between 21-56 days postpartum	Over 30 years old, primarily Spanish-speaking	Black race, under 20 years old, living in a primary care shortage area	Claims and Medi-Cal data limited the number of covariates available for analysis; parity was one important variable that was not available. Only included women insured by Medi-Cal.
Morgan et al. (2018)	n=2,204, women in Maryland who delivered between 2012-2013 and participated in the Maryland Pregnancy Risk Assessment Monitoring System (PRAMS)	Retrospective data analysis from the Maryland PRAMS survey, which is a population-based survey using a stratified random sampling methodology. Survey responses are linked to birth certificate files	Responding "yes" to the question: "Since your new baby was born, have you had a postpartum check-up for yourself?"	More than high school education, working during pregnancy	Infant death, no dental cleaning in the year before pregnancy	PRAMS is a mail-based survey, and women self-reported postpartum visit attendance, so non-response and social desirability biases may have impacted results.
Bennett, Chang, & Levine (2014)	n=31,340, Women delivering between July 2003 and December 2009 in Maryland, with GDM, HDP and/or DM (n=7,741) or without these complications (comparison group, n=23,599); most patients	Five-year retrospective cohort study utilizing two large Maryland insurance claims databases. Data were linked to 2000 Census data for sociodemographic	1.Postpartum obstetric visit within 3 months of delivery for Medicaid recipients 2.Postpartum obstetric visit	1. White race, Hispanic ethnicity, chronic hypertension, preeclampsia, GDM, cesarean delivery, depression	1. Other mental health disorders, drug or alcohol use 2. Older than 35	Claims records limit availability of some covariates. Limited power for analysis of women with commercial insurance.

	were insured by Medicaid (85%)	neighborhood characteristics	within 3 months of delivery for privately insured	2. Other mental health disorders		
Postpartum visit attendance and diabetes screening completion						
Battarbee & Yee (2018)	n=683, women with GDM who delivered at a tertiary medical center in Chicago between 2008-2016	Retrospective case-control using data from medical record abstraction	1.Postpartum visit attendance within 4 months of delivery 2. GTT completion	1. Asian 2. Medicaid insurance, non-English speaking, tobacco use, late to PNC	1. Medicaid insurance, late presentation to care, preterm delivery 2. Diagnosed with GDM after 28 weeks	Possibly unmeasured confounding, reduced power in subgroup analysis. Those referred to the medical center may have attended a postpartum visit at the facility at which they first sought care. Limited to variables and data recorded in the medical record.
Diabetes screening completion only						

Nielsen et al. (2014)	Articles (n=36) published prior to September 2012 that reported on GDM postpartum follow-up, from the US (19 articles), Australia (9), Canada (6), Denmark (1), and The Netherlands (1).	Systematic review of literature on screening, treatment, and postpartum follow up for pregnancies complicated by GDM. Search conducted with PubMed, and non-English language articles were excluded. Thirty-six articles focused on postpartum screening	Determinants of diabetes screening among postpartum women with a history of GDM	Postpartum visit with an OB/GYN		Inclusion of articles from many different countries and regions may have minimized important predictors that are location- or population-specific.
Stasenko et al. (2010)	n=745, women with GDM between 2002-2008 at an academic center in San Francisco, CA	Retrospective cohort study using abstracted data from medical records and laboratory reports	Postpartum testing with an OGTT or fasting plasma glucose within six months of delivery	Asian race, older age, nulliparous, GDM subtype A2 (medication controlled GDM)		Data quality limited by quality and completeness of electronic medical record data. All the ordinal and continuous variables were dichotomized, potentially obscuring some important relationships

Blatt, Nakamoto & Kaufman (2011)	n=23,299, women who used Quest Diagnostics laboratory services in the U.S. within six months postpartum who were diagnosed with GDM; nationally representative in terms of age and race	Retrospective study using data extracted from the Quest Diagnostics Informatics Data Warehouse that included pregnant women with GDM based on available laboratory results	Postpartum screening for diabetes within 6 months postpartum (based on first GDM screening test at 24 weeks gestation)	Asian race, older age	white race	Demographic and clinical characteristics examined were limited to age and race because of the lack of information in laboratory records. Only included women in the sample who continued to use Quest Diagnostics for laboratory services, so women who did not access any laboratory services were not included in the sample
Ehrenthal et al. (2014)	n=249, women with GDM (n=111), HDP (n=127) or both (n=11) who gave birth at a large academic obstetrical hospital in mid-Atlantic region of U.S., study period not specified; Mostly white (65%) and privately insured (70%)	Prospective cohort recruited after delivery and interviewed 3 months later	Glucose tolerance testing (GTT) reported attendance	Privately insured, at least a high school level of health literacy		Self-reported attendance at screening visits; only included those who attended the study visit interview 3 months postpartum.

Table 1. Literature review summary: predictors of postpartum visit and screening attendance, organized by outcome measured.
*indicates only bivariable analysis results available

Table 2. Demographic and clinical characteristics of women with HDP who delivered at Grady Memorial Hospital between July 1, 2016 and June 30, 2018 (n=1262), by attendance at BP check within three weeks postpartum

	Overall Sample	**Women Attending BP Follow-up**	**Women Not Attending BP Follow-Up**
	N (%)	N (%)	N (%)
Characteristic			
All Deliveries	1262 (100%)	300 (23.8%)	962 (76.2%)
HDP Diagnosis*			
Chronic Hypertension with Superimposed Preeclampsia	92 (7.3%)	26 (8.7%)	66 (6.9%)
Preeclampsia with Severe Features	180 (14.3%)	67 (22.3%)	113 (11.8%)
Preeclampsia without Severe Features	164 (13.0%)	39 (13.0%)	125 (13.0%)
Gestational Hypertension	582 (46.1%)	112 (37.3%)	470 (48.9%)
Preeclampsia complicated by HELLP Syndrome and/or Eclampsia	20 (1.6%)	12 (4.0%)	8 (0.8%)
Chronic Hypertension only	224 (17.8%)	44 (14.7%)	180 (18.7%)
Discharged with BP Medication(s)* (missing = 1)			
Yes	144 (11.4%)	49 (16.4%)	95 (9.9%)
No	1117 (88.6%)	250 (83.6%)	867 (90.1%)
Maternal Age at Delivery (years)			
<20	146 (11.6%)	33 (11.0%)	113 (11.8%)
20-29	622 (49.3%)	142 (47.3%)	480 (49.9%)
≥30	494 (39.1%)	125 (41.7%)	369 (38.4%)
Race/Ethnicity* (missing = 11)			
Non-Hispanic black	1011 (80.8%)	220 (73.6%)	791 (83.1%)
Non-Hispanic white	37 (3.0%)	16 (5.4%)	21 (2.2%)
Non-Hispanic other	28 (2.2%)	11 (3.7%)	17 (1.8%)
Hispanic	175 (14.0%)	52 (17.4%)	123 (12.9%)
Interpreter Use			
Yes	169 (13.4%)	4 (16.0%)	121 (12.6%)
No	1093 (86.6%)	252 (84.0%)	932 (87.9%)
Insurance Type			
Medicaid/Medicare	1123 (89.0%)	261 (87.0%)	862 (89.6%)
Commercial	77 (6.1%)	25 (8.3%)	52 (5.4%)
Self-pay	62 (4.9%)	14 (4.7%)	48 (5.0%)
Substance Use during Pregnancy			
Tobacco	177 (14.0%)	34 (11.3%)	143 (14.9%)
Alcohol	35 (2.8%)	7 (2.3%)	28 (2.9%)
Illicit drugs	215 (17.0%)	40 (13.3%)	175 (18.2%)
Mode of Delivery*			
Cesarean Section	427 (33.8%)	136 (45.3%)	291 (30.3%)
Vaginal Delivery	835 (66.2%)	164 (54.7%)	671 (69.8%)

Gestational Age at Delivery			
<34 weeks	103 (8.2%)	27 (9.0%)	76 (7.9%)
34-37 weeks	154 (12.2%)	30 (10.0%)	124 (12.9%)
>37 weeks	1005 (79.6%)	243 (81.0%)	762 (79.6%)
Parity*(missing=1)			
0	334 (26.5%)	97 (32.3%)	237 (24.7%)
1	127 (10.1%)	39 (13.0%)	88 (9.2%)
2	244 (19.4%)	50 (16.7%)	194 (20.2%)
3+	556 (44.1%)	114 (38.0%)	442 (46.0%)
Gestational Diabetes Mellitus*			
Yes	99 (7.8%)	31 (10.3%)	68 (7.1%)
No	1163 (92.2%)	269 (89.7%)	894 (92.9%)
Chronic Medical Conditions			
Chronic diabetes mellitus*	67 (5.3%)	23 (7.7%)	44 (4.6%)
Asthma	154 (12.2%)	32 (10.7%)	122 (12.7%)
Cardiovascular disease	13 (1.0%)	4 (1.3%)	9 (1.0%)
HIV infection	28 (2.2%)	5 (1.7%)	23 (2.4%)
Obesity	298 (23.6%)	80 (26.7%)	218 (22.7%)
Mental Illness	107 (8.5%)	29 (9.7%)	78 (8.1%)
Prenatal Care Utilization Index[a]* (missing = 6)			
Inadequate	522 (41.6%)	98 (32.8%)	424 (44.3%)
Intermediate	177 (14.1%)	39 (13.0%)	138 (14.4%)
Adequate	214 (17.0%)	64 (21.4%)	150 (15.7%)
Adequate Plus	136 (10.8%)	54 (18.1%)	82 (8.6%)
Transfer of Care	207 (16.5%)	44 (14.7%)	163 (17.0%)
Prenatal Care Provider*			
CNM or PA	204 (16.2%)	55 (18.3%)	149 (15.5%)
Centering group prenatal care	62 (4.9%)	15 (5.0%)	47 (4.9%)
OB/GYN	291 (23.1%)	68 (22.7%)	223 (23.2%)
High-risk OB/GYN	485 (38.4%)	134 (44.7%)	351 (36.5%)
Unknown/Missing	220 (17.4%)	28 (9.3%)	192 (20.0%)

Note. HELLP: Hemolysis, elevated liver enzymes, low platelet count. CNM: Certified Nurse Midwife. PA: Physician Assistant. OB/GYN: Obstetrician/Gynecologist.

[a]Prenatal Care Utilization classified according to Kotelchuck index.

* $p<0.05$, chi square test of association

Table 3. Log binomial regression model of postpartum BP screening attendance among women who delivered at Grady Memorial Hospital between July 1, 2016 and June 30, 2018 (n=1244)				
		Crude Model	**Adjusted Model**	
Variable	n	cRR (95% CI)	aRR	95% CI
HDP Type				
Gestational hypertension	575	1.00 (ref)	ref	
Chronic hypertension	222	1.02 (0.69-1.51)	0.74	0.48-1.14
Super-imposed preeclampsia	90	*1.68 (1.02-2.77)*	1.32	0.77-2.27
Preeclampsia without severe features	161	1.32 (0.87-2.00)	1.25	0.81-1.92
Preeclampsia with severe features (including HELLP syndrome & eclampsia)	196	*2.67 (1.88-3.81)*	*2.29*	*1.57-3.33*
Race/Ethnicity				
Non-Hispanic white/other	65	1.00 (ref)	1.00 (ref)	
Non-Hispanic black	1004	*0.39 (0.23-0.66)*	*0.50*	*0.28-0.88*
Hispanic	175	0.60 (0.33-1.07)	0.67	0.35-1.29
Age (years)				
<20	143	1.01 (0.66-1.56)	0.89	0.55-1.44
20-29	612	1.00 (ref)	1.00 (ref)	
≥30	489	1.16 (0.88-1.53)	1.14	0.82-1.58
Insurance type at delivery				
Medicaid/Medicare	1108	0.62 (0.38-1.02)	0.68	0.39-1.15
Commercial	76	1.00 (ref)	1.00 (ref)	
Self-Pay	60	0.62 (0.29-1.34)	0.76	0.34-1.72
Prenatal Care Utilization[a]				
Transfer of Care	207	*0.39 (0.24-0.64)*	*0.30*	*0.17-0.51*
Inadequate	514	*0.34 (0.23-0.51)*	*0.32*	*0.20-0.50*
Intermediate	176	*0.42 (0.25-0.68)*	*0.37*	*0.21-0.64*
Adequate	214	*0.62 (0.40-0.98)*	*0.60*	*0.37-0.98*
Adequate Plus	133	1.00 (ref)	1.00 (ref)	
Parity				
0	328	1.00 (ref)	1.00 (ref)	
1	126	1.04 (0.67-1.63)	0.91	0.56-1.48
2	241	*0.63 (0.43-0.94)*	*0.58*	*0.37-0.89*
3+	549	*0.63 (0.46-0.87)*	*0.63*	*0.43-0.93*
Mode of Delivery				
Vaginal Delivery	822	1.00 (ref)	1.00 (ref)	
Cesarean Section	422	*1.90 (1.46-2.48)*	*1.61*	*1.21-2.15*

Model is adjusted for all listed variables. Italics indicate statistically significant relationships.
cRR: crude risk ratio. aRR: adjusted risk ratio.
[a]Prenatal Care Utilization classified according to Kotelchuck index.

	Table 4. Reason for first healthcare visit within 3 weeks postpartum among women with HDP who delivered at Grady Memorial Hospital between July 1, 2016 and June 30, 2018		
	n	**% of all deliveries**	**% of all return visits**
Returned within three weeks postpartum	398	29.2	100
Reason for return visit			
BP check	300	22.1	75.4
Visit Related to HDP	34	2.5	8.5
Visit unrelated to HDP	64	4.7	16.1

Table 5. Sensitivity Analysis. Log binomial regression model of <u>any</u> postpartum visit attendance among women who delivered at Grady Memorial Hospital between July 1, 2016 and June 30, 2018 (n=1340)				
		Crude Model	**Adjusted Model**	
Variable	n	cRR (95% CI)	aRR	95% CI
HDP Type				
Gestational hypertension	619	1.00 (ref)	ref	
Chronic hypertension only	232	0.90 (0.63-1.28)	*0.65*	*0.44-0.96*
Super-imposed preeclampsia	103	*1.81 (1.17-2.80)*	1.38	0.86-2.22
Preeclampsia without severe features	172	1.22 (0.84-1.77)	1.14	0.77-1.68
Preeclampsia with severe features (including HELLP syndrome and eclampsia)	*214*	*2.37 (1.71-3.28)*	*2.00*	*1.42-2.82*
Race/Ethnicity				
Non-Hispanic White/Other	73	1.00 (ref)	1.00 (ref)	
Non-Hispanic Black	1082	*0.41 (0.25-0.66)*	*0.54*	*0.32-0.91*
Hispanic	185	*0.55 (0.32-0.95)*	0.67	0.36-1.22
Age (years)				
<20	156	1.06 (0.72-1.55)	0.93	0.60-1.42
20-29	659	1.00 (ref)	1.00 (ref)	
≥30	525	1.12 (0.87-1.44)	1.14	0.85-1.53
Insurance type at delivery				
Medicaid/Medicare	1190	*0.60 (0.38-0.95)*	0.65	0.40-1.06
Commercial	85	1.00 (ref)	1.00 (ref)	
Self-Pay/unknown	65	0.62 (0.31-1.23)	0.77	0.37-1.61
Prenatal Care Utilization[a]				

Transfer of Care	222	*0.43 (0.27-0.66)*	*0.31*	*0.19-0.51*
Inadequate	543	*0.36 (0.24-0.52)*	*0.33*	*0.21-0.50*
Intermediate	187	*0.43 (0.27-0.68)*	*0.38*	*0.23-0.63*
Adequate	242	0.72 (0.48-1.10)	0.67	0.42-1.06
Adequate Plus	146	1.00 (ref)	1.00 (ref)	
Parity				
0	361	1.00 (ref)	1.00 (ref)	
1	143	1.12 (0.75-1.68)	1.02	0.67-1.57
2	259	*0.64 (0.45-0.91)*	*0.60*	*0.41-0.89*
3+	577	*0.59 (0.44-0.78)*	*0.61*	*0.42-0.86*
Mode of Delivery				
Vaginal Delivery	873	1.00 (ref)	1.00 (ref)	
Cesarean Section	467	*1.93 (1.52-2.46)*	*1.70*	*1.30-2.20*

Model is adjusted for all listed variables. Italics indicate statistically significant relationships.
cRR: crude risk ratio. aRR: adjusted risk ratio.
[a]Prenatal Care Utilization classified according to Kotelchuck index.