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Risk Factors Associated with Very Low Birth Weight in a Large Urban Area, Stratified by Adequacy of Prenatal Care

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Abstract *Objectives* This study examined risk and protective factors associated with very low birth weight (VLBW) for babies born to women receiving adequate or inadequate prenatal care. *Methods* Birth records from St. Louis City and County from 2000 to 2009 were used (n = 152,590). Data was categorized across risk factors and stratified by adequacy of prenatal care (PNC). Multivariate logistic regression and population attributable risk (PAR) was used to explore risk factors for VLBW infants. *Results* Women receiving inadequate prenatal care had a higher prevalence of delivering a VLBW infant than those receiving adequate PNC (4.11 vs. 1.44 %, $p < .0001$). The distribution of risk factors differed between adequate and inadequate PNC regarding Black race (36.4 vs. 79.0 %, $p < .0001$), age under 20 (13.0 vs. 33.6 %, $p < .0001$), <13 years of education (35.9 vs. 77.9 %, $p < .0001$), Medicaid status (35.7 vs. 74.9, $p < .0001$), primiparity (41.6 vs. 31.4 %, $p < .0001$), smoking (9.7 vs. 24.5 %, $p < .0001$), and diabetes (4.0 vs. 2.4 %, $p < .0001$), respectively. Black race, advanced maternal age, primiparity and gestational hypertension were significant predictors of VLBW, regardless of adequate or inadequate PNC. Among women with inadequate PNC, Medicaid was protective against (aOR 0.671, 95 % CI 0.563–0.803; PAR −32.6 %) and smoking a risk factor for (aOR 1.23, 95 % CI 1.01, 1.49; PAR 40.1 %) VLBW. When prematurity was added to the adjusted models, the largest PAR shifts to education (44.3 %) among women with inadequate PNC. *Conclusions* Community actions around broader issues of racism and social determinants of health are needed to prevent VLBW in a large urban area.

Keywords Very low birth weight · Prenatal care · Social determinants of health · Risk factors

Significance

What is already known on this subject? Prenatal care (PNC) is often the primary defense against poor birth outcomes.

What this study adds? This study examines demographic characteristics, high risk conditions, and prematurity in adjusted odds for very low birth weight (VLBW), stratified by adequacy of PNC. Race, age, parity and gestational hypertension were risk factors for VLBW regardless of PNC status; Medicaid protective against and smoking a risk factor for VLBW among those with inadequate PNC; and education attributed to the largest risk for VLBW among those with inadequate PNC when prematurity was added to the models.

Background

In 2012, 1.4 % of all births in the United States were very low birth weight [VLBW (<1500 g)], meeting the Healthy People 2020 prevalence goals for VLBW [1, 2]. In St. Louis City and St. Louis County in the state of Missouri, however, these national goals for VLBW have yet to be achieved and racial disparities persist in terms of birth

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outcomes. Between the years 2000 and 2009, the burden of VLBW continued to exceed national recommendations, with 2.5 % of infants born at VLBW, rising up to 10.7 % for women without any prenatal care [3]. While our ability to care for these fragile infants has improved, VLBW babies remain at an increased risk for morbidity and mortality, such as neurodevelopmental impairments, recurrent hospitalizations, and chronic medical conditions [4–6]. Understanding risk factors for VLBW that are specific to the greater St. Louis region, may help in tailoring preventive efforts and increase the chances of achieving national goals in this high-risk area of the country.

Prenatal care is often the primary line of defense against poor birth outcomes, with utilization of that care presumably playing an important role in those healthy outcomes. For example, it has been reported that the risk of prematurity and growth restriction increased with decreasing levels of prenatal care [7]. Women under the age of 15 have also been found to have a significantly increased odds to have a baby that was VLBW (aOR 1.47) and significantly lower prevalence of adequate care (43 vs. 72 %), compared with women 15 years of age and older [8]. A study of birth certificate data from Colorado, found that no prenatal care (aOR 4.04), inadequate weight gain (aOR 3.97), Black, non-Hispanic race (aOR 1.50), maternal age <20 years (aOR 1.42) and greater than 35 years (aOR 1.43) were all significant risk factors of VLBW) [9]. In St. Louis City and County, VLBW has been reported as the greatest contributor to feto-infant mortality between 2000 and 2009, with inadequate prenatal care contributing to 17.3 % of the population attributable risk for VLBW [10]. The differential impact of prenatal care and prematurity, as it relates to VLBW is less well known.

Some studies that have reported that prenatal care has had no significant effect on birth weight at all. Harbert [11], for example, reported that in spite of expansions of Medicaid maternity services, the incidence of VLBW had not changed statistically in 25 years. Similarly, Piper et al. [12] found that despite increased utilization of prenatal care, defined as filling prescriptions for prenatal vitamins, there was no significant reduction in the incidence of VLBW infants. Others have reported psychosocial factors having a significant impact on birth weight, such as marital status, education, early access to care, and private insurance [13, 14]. It has also been reported that while the prevalence of inadequate prenatal care (based upon the Kessner index) was higher among low birth weight (LBW) babies than non-LBW babies (44.7 vs. 30.8 %), there was no significantly increased odds of having a LBW baby based adequacy of prenatal care category [15]. In fact, a more recent study of prenatal care utilization among North Carolina teen mothers, using the adequacy of prenatal care utilization (APNCU), reported that prenatal care only explained 2 % of the variance regarding birth weight [16]. Importantly, concerns have been raised that these previous studies assessing the relationship between prenatal care and birth weight were faulty because the study designs did not sufficiently adjust for prematurity bias, selection bias, and other confounders such as maternal medical risks, race, maternal age, smoking, parity, maternal weight gain, and socioeconomic status [9].

Building upon this previous literature, we explored risk factors associated with VLBW in greater St. Louis, stratified by adequacy of prenatal care. In addition to the risk factors typically used in adjusting odds ratios in assessing the relationship between prenatal care and birth weight (age, education, Medicaid status, and parity), we also considered high-risk conditions such as diabetes hypertension, eclampsia, and smoking. Finally, we explored the influence of prematurity bias as it relates risk factors for VLBW.

Methods

The study design is a birth cohort study of singleton birth in St. Louis City and County from 2000 to 2009. The exposure criterion for our study was adequacy of prenatal care and the study outcome was VLBW (<1500 g). This study was done with approval from the Institutional Review Board of Saint Louis University.

Study Population

Live singleton births in St. Louis City and County from 2000 to 2009 were analyzed in this retrospective cohort. Data were obtained from birth certificates filed with the Missouri Department of Health and Senior Services in accordance with state law. The original sample size was 160,189, data that was categorized as fetal deaths were excluded (642). An additional 6957 were also excluded due to missing data on adequacy of prenatal care, resulting in a final sample size of 152,590.

Measures

The exposure of interest is adequacy of prenatal care as identified by birth certificate records, and reported as yes or no. Inadequate prenatal care was defined as fewer than five prenatal visits for pregnancies <37 weeks gestation, fewer than eight visits for pregnancies 37 weeks gestation or more, or care beginning after the first 4 months of pregnancy, resulting in two categories: inadequate and adequate.

The outcome of interest is VLBW defined as weighing <1500 g. Infants weighing <500 g were excluded. Other

risk factors, including race (White, Black), education level (<13, ≥13 years), maternal age (≤20, 21–34, >34), Medicaid status (yes, no), parity (primiparous, multiparous), smoking status (yes, no), chronic hypertension (yes, no), pregnancy induced hypertension (yes, no), eclampsia (yes, no) were explored, and gestational age (<32, 32–36, >36 weeks).

Data Analysis

Data was categorized across risk factors and stratified by adequacy of prenatal care. Chi square tests were used to assess differences between covariates, at a significance level of 0.05. To assess if the exposure of prenatal care was associated with the outcome of VLBW a Chi square test was performed. Three models were used to evaluate the odds of various risk factors as they related to VLBW. Bivariate logistic regression was used in model one which calculated crude odds ratios. Multivariable logistic regression was used in model two, which adjusted all the odds for all of the other covariates except gestational age. Model three added gestational age to model two. Population Attributable Risk Factors were also calculated for selected risk factors, within each analytic model. PAR% was calculated as follows: $PAR\% = P(OR - 1)/[P(OR - 1) + 1]$, where P = prevalence of the risk factor. The PAR% represents the proportion of VLBW that can be attributed to the risk factor of interest. The 95 % confidence intervals are reported for all odds ratios. All data was analyzed using SAS 9.3.

Results

Of our 152,590 birth records explored, 16,342 (10.7 %) did not receive adequate prenatal care. Table 1 shows the demographics of women who gave birth in St. Louis City or County from 2000 to 2009. Of the entire population,

Table 1 Demographic characteristics of all live births, St. Louis City and County, 2000–2009 (N = 152,590)

Risk/preventive factors	Overall	Adequacy of PNC		*p* value
	Total population N = 152,590 (%)	Adequate N = 136,248 (%)	Inadequate N = 16,342 (%)	
Race				<0.0001
Black	62,457 (40.93 %)	49,546 (36.36 %)	12,911 (79.01 %)	
White	90,133 (59.07 %)	86,702 (63.64 %)	3431 (20.99 %)	
Maternal age				<0.0001
<20	23,207 (15.21 %)	17,710 (13.00 %)	5497 (33.64 %)	
21–34	100,225 (65.68 %)	90,937 (66.74 %)	9288 (56.84 %)	
>34	29,158 (19.11 %)	27,601 (20.26 %)	1557 (9.53 %)	
Maternal education				<0.0001
<13 years	61,125	48,638 (35.91 %)	12,487 (77.91 %)	
13+ years	90,345	86,804 (64.09 %)	3541 (22.09 %)	
Medicaid (yes)	60,393 (39.84 %)	48,266 (35.65 %)	12,127 (74.93 %)	<0.0001
Parity				<0.0001
Primiparous	61,745 (40.46 %)	56,619 (41.56 %)	5126 (31.37 %)	
Multiparous	90,845 (59.54)	79,629 (58.44 %)	11,216 (68.63 %)	
Smoking (yes)	17,208 (11.31 %)	13,215 (9.73 %)	3993 (24.52 %)	<0.0001
Diabetes (yes)	5893 (3.86 %)	5494 (4.03 %)	399 (2.44 %)	<0.0001
Chronic hypertension (yes)	2613 (1.71 %)	2319 (1.70 %)	294 (1.80 %)	0.3646
Pregnancy induced hypertension (yes)	8644 (5.67 %)	7731 (5.67 %)	913 (5.59 %)	0.6524
Eclampsia (yes)	96 (0.06 %)	83 (0.06 %)	13 (0.08 %)	0.3690
VLBW (yes)	2628 (1.72 %)	1957 (1.44 %)	671 (4.11 %)	<0.0001
Gestational age				<0.0001
<32	3553 (2.33 %)	2580 (1.89 %)	973 (5.95 %)	
32–36	20,296 (13.30 %)	17,701 (12.99 %)	2595 (15.88 %)	
37+	128,741 (84.37 %)	115,967(85.11 %)	12,774 (78.17 %)	

2628 (1.72 %) were very low birth weight, and 3553 (2.33 %) were under 32 weeks, 20,296 (13.30 %) were 32–36 gestational age, and 128,741 (84.37 %) were full term. Significant differences in the prevalence of risk factors were found for women with and without adequate prenatal care, regarding the following variables: black race, maternal age, maternal education, Medicaid status, parity, smoking status, diabetes, VLBW, and gestational age ($p < 0.05$). Amongst women who did not receive adequate prenatal care, 79.0 % were black. Additionally, 33.6 % were under 20 years of age. Nearly eighty percent (77.9 %) had completed less than a high school education, compared with 35.9 % of women receiving adequate PNC. Seventy-four percent (74.9 %) of women receiving inadequate PNC were on Medicaid. Twenty-four percent (24.5 %) were smokers, as compared to 9.7 % of women receiving adequate PNC. Chi square demonstrated that women receiving inadequate prenatal care were more likely to deliver a VLBW infant than those receiving adequate prenatal care (4.11 vs. 1.44 %, $p < .0001$). Additionally, almost six percent (5.95 %) of women receiving inadequate PNC gave birth at <32 weeks gestational age.

In Table 2, crude and adjusted odds ratios, as well as prevalence and percent-attributable risk (PAR) for each covariate were calculated for risk of VLBW among women who received inadequate prenatal care. Model 1 provides crude associations. Model 2 adjusts for all covariates except for gestational age. This model found black race, advanced maternal age, lack of Medicaid, primiparity, positive smoking status, and pregnancy-induced hypertension to all be significantly associated with the odds of delivering a VLBW baby. Within Model 2, Black women receiving inadequate PNC had an 85 % increase (aOR 1.85, 95 % CI 1.46–2.33) in the likelihood of having a VLBW baby. This accounted for 40.1 % of the PAR. Parity significantly increased the odds of a VLBW baby by 35 % (aOR 1.35, 95 % CI 1.11–1.64) and accounting for 9.9 % of the PAR. Smoking also significantly increased the risk for VLBW babies (aOR 1.23, 95 % CI 1.01–1.49) accounting for 5.2 % of the PAR. Pregnancy induced hypertension significantly increased the risk for VLBW by 88 % (aOR 1.88, 95 % CI 1.44–2.45) accounting for 4.7 % of the risk. For women with inadequate prenatal care, being over the age of 34 resulted in a 56 % increase (aOR 1.56, 95 % CI 1.22–2.01) in the odds of delivering a VLBW infant. However, due to the low prevalence of advanced-age mothers, the PAR remained relatively small (5.1 %). Medicaid was a protective factor, with women on Medicaid decreasing their odds of having a VLBW baby by 33 % (aOR 0.67, 95 % CI 0.56–0.80), reducing the PAR by 32.6 %. When prematurity is accounted for in the model (model 3), only parity and gestational age remain

Table 2 Inadequate prenatal care: risk for very low birth weight (n = 15,858)

Risk/preventive factors for women with inadequate prenatal care	Model 1				Model 2				Model 3			
	COR	95 % CI	Prevalence	PAR%	AOR	95 % CI	Prevalence	PAR%	AOR	95 % CI	Prevalence	PAR%
Maternal race: black	**1.53**	1.23–1.91	0.79	29.5	**1.85**	1.46–2.33	0.79	40.1	1.21	0.86–1.71	0.79	14.2
Maternal age <20	1.12	0.94–1.31	0.34	3.9	0.99	0.81–1.22	0.34	–0.3	1.01	0.75–1.37	0.34	0.5
Maternal age >34	**1.67**	1.30–2.13	0.10	6.3	**1.56**	1.22–2.01	0.10	5.1	1.02	0.70–1.47	0.10	0.1
Maternal education <13	0.84	0.70–1.01	0.78	−14.3	0.84	0.69–1.03	0.78	−14.3	0.61	0.45–0.82	0.78	−44.3
Medicaid: yes	**0.67**	0.57–0.80	0.75	−32.9	**0.67**	0.56–0.80	0.75	−32.6	0.92	0.70–1.20	0.75	−6.7
Parity: primiparous	**1.28**	1.08–1.50	0.31	8.0	**1.35**	1.11–1.64	0.31	9.9	**1.69**	1.26–2.26	0.31	17.7
Smoking: yes	1.06	0.88–1.27	0.25	1.5	**1.23**	1.01–1.49	0.25	5.2	0.84	0.64–1.10	0.25	−4.2
Diabetes: yes	0.98	0.58–1.66	0.02	−0.04	0.74	0.44–1.27	0.02	−0.6	0.72	0.35–1.51	0.02	−0.7
Chronic hypertension: yes	**1.85**	1.16–2.93	0.02	1.7	1.53	0.96–2.46	0.02	0.9	1.59	0.76–3.33	0.02	1.1
Pregnancy induced hypertension: yes	**2.07**	1.60–2.70	0.06	6.0	**1.88**	1.44–2.45	0.06	4.7	0.91	0.62–1.35	0.06	−0.5
Eclampsia: yes	4.38	0.97–19.75	0.00	0.2	3.87	0.84–17.74	0.00	0.3	5.32	0.21–133.95	0.00	0.4
Gestational age: <32 versus ≥37	>999.99	741.86 to >999.99	0.06	–	X	X	X	X	>999.99	800.07 to >999.99	0.06	–
Gestational age: 32–36 ≥37	**17.04**	9.74–29.81	0.16	72.0	X	X	X	X	18.04	10.29–31.63	0.16	73.2

Bold values are statistically significant

Table 3 Adequate prenatal care: risk for VLBW (n = 134,286)

Risk/preventive factors for women with adequate prenatal care	Model 1				Model 2				Model 3			
	COR	95 % CI	Prevalence	PAR%	AOR	95 % CI	Prevalence	PAR%	AOR	95 % CI	Prevalence	PAR%
Maternal race: black	**2.31**	2.11–2.53	0.36	32.2	**2.32**	2.08–2.59	0.36	32.0	**1.19**	1.03–1.39	0.36	6.6
Maternal age <20	**1.24**	1.09–1.41	0.13	3.0	**0.84**	0.73–0.97	0.13	−2.1	**0.81**	0.66–0.99	0.13	−2.5
Maternal age >34	1.01	0.90–1.14	0.20	0.2	**1.23**	1.09–1.40	0.20	4.4	0.91	0.76–1.08	0.20	−1.9
Maternal education <13	**1.40**	1.30–1.54	0.36	12.6	1.10	0.98–1.23	0.36	3.3	**0.85**	0.72–0.99	0.36	−5.7
Medicaid: yes	**1.44**	1.31–1.57	0.36	13.7	0.92	0.81–1.03	0.36	−3.1	0.91	0.72–1.00	0.36	−3.5
Parity: primiparous	**1.15**	1.05–1.25	0.42	5.9	**1.15**	1.04–1.28	0.42	6.0	**1.45**	1.26–1.66	0.42	15.7
Smoking: yes	1.09	0.94–1.27	0.10	1.0	1.15	0.99–1.34	0.10	1.5	0.87	0.70–1.07	0.10	−1.3
Diabetes: yes	1.18	0.95–1.46	0.04	0.9	0.89	0.71–1.10	0.04	−0.5	**0.60**	0.45–0.80	0.04	−1.6
Chronic hypertension: yes	**2.34**	1.84–2.96	0.02	2.6	**1.49**	1.16–1.90	0.02	0.8	1.06	0.74–1.51	0.02	0.1
Pregnancy induced hypertension: yes	**4.82**	4.31–5.39	0.06	18.6	**4.27**	3.81–4.78	0.06	15.7	**2.22**	1.87–2.64	0.06	6.5
Eclampsia: yes	**10.94**	5.79–20.79	0.00	0.8	**9.26**	4.80–17.87	0.00	0.8	**4.93**	1.75–13.87	0.00	0.4
Gestational age: <32 versus ≥37	>999.99	>999.99 to >999.99	0.02	–	X	X	X	X	>999.99	>999.99 to >999.99	0.02	–
Gestational age: 32–36 ≥37	**99.02**	65.48–149.76	0.13	92.7	X	X	X	X	**93.40**	61.66–141.46	0.13	92.3

Bold values are statistically significant

significant. Women with previous pregnancies are 69 % more likely to have a VLBW (aOR 1.69, 95 % CI 1.26, 2.26) accounting for 17.7 % of the PAR, and when compared with full term births, women who gave birth to a baby between 32 and 36 weeks gestational age were 18 times more likely to have a VLBW baby (aOR 18.04, 95 % CI 10.29–31.63), accounting for 73.2 % of the PAR.

Table 3 shows crude and adjusted odds ratios, prevalence, and PAR for risk and preventive factors for VLBW for women who received adequate prenatal care. After adjustment, black race, advanced maternal age, primiparity, hypertension (both chronic and pregnancy-induced), and eclampsia were all significantly associated with increased odds of having a VLBW infant. Only young maternal age (<20) was significantly associated with a decrease in the odds of having a VLBW infant. Black women receiving adequate prenatal care had a 132 % increase in the odds (aOR 2.32, 95 % CI 2.08–2.59) of delivering a VLBW baby. Women of an advanced maternal age increased their odds by 23 % (aOR 1.23, 95 % CI 1.09–1.39). Primaparous women had a 15 % increase in odds of having a VLBW delivery (aOR 1.15, 95 % CI 1.04–1.28). Having chronic hypertension resulted in an increase in odds of having a VLBW baby of 49 % (aOR 1.49, 95 % CI 1.16–1.90), while pregnancy-induced hypertension increased the odds by 327 % (aOR 4.27, 95 % CI 3.81–4.78). Finally, those with eclampsia had 826 % (aOR 9.26, 95 % CI 4.80–17.87) greater odds of delivering a VLBW infant. Being under the age of 20 resulted in a 16 % decrease (aOR 0.84, 95 % CI 0.73–0.97) in the odds of having a VLBW infant. Maternal education level, Medicaid status, smoking status, and being diabetic all had no significant impact on VLBW odds. The highest percent-attributable risk factor for women who received adequate prenatal care was race, with a value of 32.4 %. This was followed by pregnancy-induced hypertension, with 15.7 % of the PAR. When prematurity was accounted for in the model (Model 3), black race, parity, pregnancy induced hypertension (PIH), eclampsia, and prematurity (32–36 week gestation) were significantly associated with VLBW. Women without previous pregnancies were 45 % more likely to have a VLBW (aOR 1.45, 95 % CI 1.26, 1.66) accounting for 15.7 % of the PAR. Women with PIH had a 2.2 increased odds of VLBW (aOR 2.22, 95 % CI 1.87, 2.64) and women with eclampsia had a 4.9 increased odds of VLBW (aOR 4.93, 95 % CI 1.75, 13.87), accounting for 6.5 %, and 0.4 % of the PAR, respectively. When compared with full term births, women who gave birth to a baby between 32 and 36 weeks gestation had 93 increased odds of having a VLBW baby (aOR 93.4, 95 % CI 61.66–141.46), accounting for 92.3 % of the PAR.

Discussion

Women receiving inadequate prenatal care were more likely to deliver a VLBW infant than those receiving adequate prenatal care (4.11 vs. 1.44 %, $p < .0001$). Our first adjusted model, that did not include prematurity (model 2), found Black race, age >34, primiparity, gestational hypertension, and eclampsia were significant predictors of VLBW, regardless of adequacy of care, with Black race accounting for the largest PAR (inadequate: 40 % PAR; adequate: 32 % PAR). Among women with adequate prenatal care, maternal age under 20 was protective against VLBW and chronic hypertension was a risk factor for VLBW. Among women with inadequate prenatal care, being on Medicaid was protective against VLBW and smoking was a risk factor for VLBW. It is interesting to note that Medicaid played a protective role for VLBW among those with inadequate prenatal care but not among those with adequate prenatal care, and conversely that smoking was a risk factor for VLBW among those with inadequate prenatal care but not among those with adequate prenatal care. Perhaps the negative effects of inadequate care are mediated by benefits offered through Medicaid services while the negative effects of smoking are exacerbated through inadequate attainment of prenatal care.

Being born early, that is, before the 37th week of gestation, was the largest risk factor for a baby to be born at a VLBW. Being born at 32–36 weeks, in reference with full term births accounted for 73 % of the risk for VLBW among those with inadequate prenatal care and 92 % of the risk for those with adequate prenatal care, after adjusting for all the other confounders. Other risk factors for VLBW also changed when prematurity was added to the model (model 3), with different patterns emerging between inadequate and adequate prenatal care. Among women with inadequate prenatal care, parity and education accounted for 17.7 and 44.3 % of the PAR, respectively, while Medicaid and Black race accounted the largest PAR (−32.6 and 40.1 %) without prematurity in the model. Parity has been previously described as a risk factor for VLBW outcome [17]. However, for women receiving adequate prenatal care, the largest PAR for VLBW was primiparity (15.7 %) followed by Black race (6.6 %) when prematurity was in the adjusted model, as opposed to Black race (32 %) and PIH (15.7 %) as the largest contributors to PAR when prematurity was not in the adjusted model. Among women with adequate prenatal care, black race, primiparity, PIH, and eclampsia remained significantly associated with VLBW within the adequate prenatal care strata. It is important to note that while diabetes was significantly protective against VLBW, that is not only a likely artifact from the association between maternal diabetes and large for gestational age as well as accounting for only a small fraction of PAR. The findings from model 2 are important, as the relationship between prematurity and VLBW are likely correlated with similar risk factors, and the emergence of Black race and parity as important drivers of PAR should be used to inform programs and policies designed to combat this highly important public health concern. However, it is also important to consider effect of prenatal care on VLBW independent of prematurity, and especially notable that 44.3 % of the PAR among those with inadequate prenatal care was due to with maternal education. Education is an important gatekeeper of health, and this finding underscores the need for community conversation and action regarding education and birth outcomes.

Though this is a strong study, based on the large population based sample size and temporality, there are limitations. The study was of data collected in St. Louis and St. Louis County, which may decrease the generalizability of this study to other geographical locations. There may also be underestimates regarding the number of prenatal care visits resulting in women inaccurately being placed in the inadequate prenatal care category rather than the adequate prenatal care category, resulting in underestimates of differences between groups [18–22]. In addition, other unmeasured health indicators that may put women at greater risk for poor outcomes whom over received adequate-plus prenatal care, a category that is pooled within the adequate prenatal care and may also result in underestimated differences between prenatal care categories. Finally, we were unable to assess such information as pregnancy intention, which has been shown to have an important influence on seeking prenatal care [23]. In spite of these limitations, which we hypothesize would have diminished the differences between groups, we still found significant and possibly underestimated differences between prenatal care categories.

Our study provides important advances to understanding the relationship between prenatal care and the prematurity bias, as they are related to VLBW. Previous studies have been contradictory, some showing that prenatal care has no effect on VLBW outcomes, while others have shown a positive effect of adequate prenatal care on birth weight. We advance this literature by carefully considering the differential role of prenatal care and the potential impact of the prematurity bias. Importantly, we continued to find that Black race was associated with VLBW regardless of prenatal care and that Medicaid for women with inadequate prenatal care was protective, consistent with other studies [11, 24]. In St. Louis City and County in 2012, while 17 % (95 % CI 16.6–18.3) of White births are to mothers on

Medicaid, 79 % (95 % CI 77.8–79.6) of Black/African-American births are to mothers on Medicaid [3]. This shows that Race and Medicaid status are differentially distributed in this large urban area, and further research is needed to disentangle this relationship and should consider the role of poverty. St. Louis is a very racially segregated city, and we encourage a more detailed exploration of VLBW geographically, such as zip code, census track, or even blocks, to help understand the Race–VLBW–Medicaid relationship, as certain areas, such as North County, are known to have fewer hospitals and health resources. These future studies are needed if we want to act upon the inequity we have in health outcomes in our community in a meaningful way. Community actions around broader issues of racism and social determinants of health are needed to prevent VLBW in a large urban area.

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