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Multilevel Assessment of Prenatal Engagement in Home Visiting

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Abstract

Background—Low engagement in prenatal home visiting may limit program effectiveness to improve birth outcomes. Multiple factors may influence engagement.

Methods—A retrospective cohort study of first-time mothers enrolled in home visiting prenatally in southwest Ohio from 2007 to 2010. The primary outcome was enrolment by 20weeks' gestation; a secondary outcome included home visit frequency. Two multilevel assessments were conducted using random intercept multilevel modelling; maternal covariates were nested first within the home visiting agency and then within the ZIP code. In the first model, variations attributable to individual agency and agency volume were assessed. In the second model nested within the ZIP code, violence rates by ZIP code and interaction terms between violence rates and maternal factors were evaluated.

Results—Of 837 women, 25.3% enrolled 20 weeks and 7.4% enrolled early and received 75% of expected visits. The first model demonstrated a significant variation in early enrolment based on clustering by agency ($p < 0.001$), however, agency volume was not a significant predictor. In the second model, violence rate was not associated with early enrolment (AOR 0.92, $p = 0.08$), but an interaction term with maternal race was significant ($p = 0.02$). The effect of increasing community violence disproportionately affected early enrolment among white women (AOR 0.80, $p = 0.005$) compared with black women (AOR 0.95, $p = 0.30$). In both the random intercept

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COMPETING INTERESTS

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multilevel models, teenagers demonstrated a decreased likelihood of enrolling early (AOR 0.58, $p=0.046$ and AOR 0.49, $p=0.004$).

Conclusions—Prenatal home visiting engagement is related to maternal, agency, and community factors, presenting multiple opportunities to optimize program implementation.

Keywords

Home visit; Pregnancy; Premature birth

INTRODUCTION

One goal of home visiting programs is to reduce birth outcome disparities through education, social support and care coordination. [1] While programs have demonstrated promising results, [2–6] current experience suggests that most who enroll in home visiting prenatally receive a low dosage of this intervention. [7–9] Since pregnancy risk factors may only be modifiable if intervention begins early and at a sufficiently high intensity, [10] an increasing exposure to home visiting prenatally may be critical to maximizing program effectiveness. Moreover, women who enroll early in pregnancy are more likely to remain in services and to complete more home visits. [11]

In this study, we utilize a hierarchical framework [12] to evaluate individual and contextual factors associated with two aspects of prenatal home visiting engagement: enrolment timing and participation intensity once enrolled. As shown in figure 1, at the most proximal level, our conceptual model includes maternal characteristics that influence engagement due to self-perception of risk, material and psychosocial needs and cultural acceptance of participation.[11, 13–19] We hypothesized that at a higher level, agency and community influence early prenatal engagement in home visiting via mechanisms related to program delivery and access; [11, 17, 18, 20] these two sets of contextual factors also relate to each other on the basis of agency connectivity to referral sources, agency outreach efforts in the community, and geographic catchment areas of the agencies.

METHODS

Study design and patient population

This retrospective, cohort study examined first-time mothers enrolled prenatally within a large home visiting program serving southwest Ohio during the years 2007–2010. This program is managed by Cincinnati Children’s Hospital Medical Center (CCHMC) in partnership with local home visiting agencies. From 2007–2010, all but one agency used the Healthy Families America (HFA) model of home visiting, in which eligibility for enrollment extends throughout pregnancy and until the infant’s third month of age. We omitted data from one agency using the Nurse Family Partnership (NFP) home visiting model, which in contrast to HFA agencies requires enrollment prior to 28 weeks of pregnancy.

In addition to being first time mothers, eligible participants must have at least one of four eligibility characteristics: 1) unmarried, 2) low income ($\leq 300\%$ of poverty level, Medicaid-insured or reported financial concerns), 3) <18 years old, or 4) suboptimal prenatal care

(broadly defined with no specific gestational age cut-off). Of these four criteria, suboptimal prenatal care is the least commonly used with <5% of participants enrolled on this basis alone (personal communication, program referral coordinators). For prenatal participants, targeted visit frequency is weekly for the first four weeks, biweekly until 36 weeks' gestation, and then weekly again until birth.

Data sources

Home visiting data were abstracted from a web-based system used to collect service provision data. [21] These were linked to vital statistics, provided by the Ohio Department of Health (ODH), and birth hospital discharge records, available from the Ohio Hospital Association, using SAS-based probabilistic matching. [22] The linked record set represented 88.2% of the total home visited population during the study period. Further details of linkage, including match rates and validation procedures, have been described previously. [22] Finally, ZIP codes were linked to aggregate data maintained by Hamilton County Public Health. The ODH and CCHMC Institutional Review Boards approved this study.

Predictors

Maternal factors—Maternal variables included race, ethnicity, age, education level, marital status and smoking. Clinical variables were constructed using the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes and vital statistics data, including hypertensive disorders, diabetes and obesity (body mass index ≥ 30). We also measured previous poor birth outcomes (fetal loss, stillbirth or perinatal death) affecting those women who experienced a prior pregnancy but have not yet mothered an infant. Variables selection was based on their importance for pregnancy risk, [23–25] potential influence on obstetrical referral patterns, and maternal identification as being 'at-risk'. [18]

Agency and referral source—Referral source was categorized as 1) home visiting agencies, 2) hospitals and clinics, and 3) other community sources (self, family member, schools and other organizations). Referral from an agency may occur through local outreach efforts or when a pregnant woman is receiving other agency services and is identified as eligible for home visiting. For each referral, a central office assigns an agency on the basis of home visitor availability as well as maternal ZIP code.

Since prior work suggests that home visitor caseload influences retention, [11] we derived a variable representing agency volume (average annual number of delivered home visits by agency). In the absence of empirical evidence for what constitutes an 'ideal' client volume, cut-offs were ascertained by distribution of the data using quartile values. These were classified as follows: low (< 1500 home visits); low-medium (1501–2000 home visits), medium-high (2001–4000 home visits) and high (>4000 home visits).

Community factors—Rates of violent injury (e.g., assaults, homicides) by maternal ZIP code were aggregated over the years 2004–2011 and averaged as an annual count per 1000 residents. A 2-unit change in this ZIP code rate corresponded to approximately a 0.5 standard deviation in the distribution of rates for the sample. A binary cutoff was also

assessed using a rate of 11 per 1,000 residents, which was the mean rate for ZIP codes in the sample.

Outcomes

Our primary outcome was early prenatal enrollment, defined as receipt of first home visit by 20 weeks gestation (mid-point of the second trimester). We selected 20 weeks based on the rationale that behavioral interventions initiated later in pregnancy would be unlikely to affect pregnancy trajectory. [26]

A secondary outcome representing high service intensity included enrolment by 20 weeks' gestation and also receipt of 75% expected prenatal home visits, based on the program's curriculum. [27] To account for women who experienced preterm delivery, we adjusted the expected number of visits for length of gestation.

Analysis

We performed a multilevel analysis, in which maternal predictors of prenatal engagement were assessed with two higher levels of contextual factors: 1) home visiting agency and 2) community violence. Since each community is served by multiple agencies and each agency covers multiple communities, as well as the relatedness of these two sets of effects with each other, we felt that two separate models would best allow us to evaluate and interpret the distinct effects of agency and community. Two separate random intercept multilevel analyses were conducted, the first with agency as a higher level effect, and the second with ZIP code. First, maternal characteristics were assessed in univariable logistic regression; those factors deemed clinically important or with p values <0.15 were retained in random intercept multilevel modelling using a logit link function and binary distribution. [28] Parameter estimates were determined statistically significant at an alpha of 0.05. Model diagnostics included assessment for multicollinearity, with variance inflation factors for all retained variables <10. Since <1% of data were coded as missing or unknown for key analytic variables, casewise deletion was used for missing data. Analyses were performed using SAS 9.3.

Agency analysis—We compared a standard multivariable logistic model with a random intercept multilevel model including maternal factors as a first level of predictors nested within agency as a second level effect. Variation in the model attributable to agency was assessed using a χ^2 test of the covariance parameters. Next, we assessed the effect of agency volume as a second level predictor. Cross-level interaction terms between agency volume and maternal factors were tested for statistical significance (based on a type III test p value <0.05). Finally, comparisons of prenatal enrolment across agencies were transformed into predicted probabilities stratified by maternal age.

Community analysis—For the analysis with community violence, we began with a random intercept multilevel model with maternal predictors as a first level nested within ZIP code as a second level effect. Next, we assessed the significance of adding violence rate by ZIP code as a higher level predictor. Cross-level interaction terms between violence rates

and maternal factors were added and tested. Lastly, comparisons of prenatal enrolment by violence rates were transformed into predicted probabilities.

Cross-classified analysis—Finally, in addition to the separate models above, we fitted a cross-classified multilevel model to examine the simultaneous effects of community violence and agency volume as second level predictors. As above, this was specified as a random intercepts model with a logit link function. SAS Proc GLIMMIX was used to estimate and evaluate model parameters.

RESULTS

A total of 1934 women were enrolled in the program between 2007 and 2010 with a linked Ohio birth certificate. Of these, 48% (928) were potentially eligible for study inclusion based on prenatal enrolment, while the rest were enrolled after giving birth. Compared to women who enrolled after delivery, prenatal participants had similar rates of smoking, obesity and prenatal hypertension (all p-values >0.05), although they were slightly more likely to be black (66.2% vs 60.3%, p=0.002), unmarried (97.0% vs 92.7%, p<0.001) and have a sexually transmitted infection (22.4% vs 17.5%, p=0.007); they were also less likely to be Hispanic (4.9% vs 12.3%, p<0.001) or to have completed high school (45.6% vs 50.1% p=0.03). Of 928 prenatal participants, 91 were excluded due to being served by the NFP agency, yielding a final sample of 837 women representing 8 HFA agencies. The number of women in the sample served by each agency ranged from 48 to 149. Fifty-five ZIP codes were represented, with >50% of the sample residing within 10 ZIP codes, the most populated of which contained 82 participants and was served by all eight agencies. Of this sample, 25.3% (n=212) enrolled before 20 weeks' gestation, while 7.4% (n=62) had the composite measure of enrolment by 20 weeks and 75% of expected visits. Table 1 depicts the percentage of women with these outcomes by clinical and demographic characteristics. For the primary outcome, the following variables were retained for multivariable modelling based on a univariable p-value <0.15: race, age <18 years, smoking status and referral source; education was also retained on the basis of its empirical relevance. [29]

Agency analysis

Multilevel modelling demonstrated variation based on clustering by agency, with the χ^2 test of covariance parameters p-value <0.001. Agency volume as a higher level predictor was not statistically significant (table 2). Teenagers demonstrated a decreased likelihood of enrolling early (adjusted OR (AOR) 0.58, 95% CI 0.34 to 0.99). Figure 2 depicts the predicted probabilities of early prenatal engagement by agency, stratified by teenage status, which ranged from 0.14 to 0.40 across agencies. Testing for a cross-level interaction effect between agency volume and teenage status was not statistically significant. In the model of high service intensity (table 2), agency volume was still not significant, and the effect of young maternal age was no longer significant (AOR 0.62, 95% CI 0.27 to 1.45). Repeating primary and secondary analyses using agency volume as a continuous variable (unit difference of 1000 home visits) resulted in narrower CIs but no significant associations with either early enrolment (AOR 1.07, 95% CI 0.67 to 1.70) or high service intensity (AOR 1.05, 95% CI 0.56 to 1.98); other parameters were not substantially changed.

Community analysis

ZIP code violence rates ranged from 3/1000 (1.7% of the cohort) to 19/1000 (9.7% of the cohort), with a mean of 11. While variation in community violence was similar among white, black and other races (SDs of 4.8, 4.9 and 5.2, respectively), white mothers tended to reside in less violent neighborhoods (mean 8.7/1000, 95% CI 8.0 to 9.4, compared with black mothers, mean 12.3, 95% CI 11.9 to 12.7 and other races, mean 12.1, 95% CI 10.6 to 13.6).

Multilevel modelling demonstrated variation based on clustering by ZIP code, with the χ^2 test of covariance parameters p-value <0.001. ZIP code violence rate as a higher level predictor was not statistically significant (AOR 0.92, 95% CI 0.84 to 1.01); however, a cross-level interaction term between violence rate and race was (type III test p-value 0.02). As shown in table 3, ORs for this interaction term indicate that white women were more affected by increasing violence rates compared with black and other race groups. For white women, we observed an approximately 20% reduction in the odds of early engagement associated with each 2-unit increase in violence rate (e.g., 11.43 vs 13.43 per 1000), while for black women the reduction was approximately 5%. Maternal age ≥ 18 years and referral by a home visiting agency (vs other community source) were associated with a higher likelihood of early enrolment. Figure 2B depicts the predicted probability of early enrolment based on community violence rates, stratified by race.

For the secondary analysis, variables included race, age, educational attainment and hypertension. Table 3 depicts results modelled similar to the above with community violence rate as a higher level predictor and a cross-level interaction term between violence rate and race. Results were similar to the model of enrolment by 20 weeks, but with larger effect sizes. Of note, maternal diagnosis of hypertension was associated with higher intensity of service (AOR 2.81, 95% CI 1.32 to 5.98).

Cross-classified analysis

Results of the cross-classified multilevel model of enrolment ≥ 20 weeks were substantively unchanged from those depicted in tables 2 and 3 (data not shown). We found no difference in early enrolment based on agency volume, while the interaction effect between violence rate and race was observed as above. With this model, we also examined the proportion of variance attributable to higher level effects, which was approximately 7.5%, most of which was accounted for by ZIP code. Owing to the insufficient sample size and minimal variation attributable to higher level predictors when agency and community were included, a cross-classified model for the outcome of high service intensity could not be estimated.

DISCUSSION

Since home visiting programs focus on perinatal outcomes, measurement of who is not receiving optimal program exposure may be important in determining how implementation should be refined.[30, 31] Current findings indicate that few participants enroll early in pregnancy and receive the number of visits intended per the program curriculum. Prenatal

engagement is associated with maternal characteristics, but variation is also influenced by community of residence and to a lesser effect by agency.

Although the parameters for age and education level were not identical across the separately fitted models, their directionality and general effect size were similar. These findings are consistent with results of prior work demonstrating that younger and less-educated women are less likely to enroll.[18, 32] Interventions to engage teenagers early may be important for program effectiveness, particularly given their higher risk of preterm birth. [33] Conversely, in our secondary analysis, hypertension was significantly associated with increased engagement. This may reflect elevated maternal perceptions of pregnancy risk, [15] and would suggest that early engagement may be more likely among women who are at highest risk or at lowest risk, for divergent reasons.

We observed that women referred by agencies are more likely to enroll early compared with other referral sources. This most likely reflects bias based on who is more likely to already be engaged with these organizations, but it may also reflect process differences for prenatal referral, including when and how home visiting is offered. Referral from clinics and hospitals was not different from other community sources, potentially because obstetrical providers are more likely to refer women with late prenatal care. This may suggest further opportunities to enhance partnerships with obstetrical providers to ensure a rapid, reliable referral process for all eligible women, including those who began early prenatal care.

We did find variation in prenatal enrolment timing by agency, consistent with prior studies on outcomes such as retention. [14, 34] We were unable to attribute this to agency volume, although previous work suggests that there may be an important effect of home visitor caseload on variability in retention.[14] In the context of prenatal enrolment, agency variation may relate to other processes including follow-up after referral, outreach in the community and breadth of other agency services.

Families living in high-risk communities may be less likely to feel hopeful, interact positively with their neighbors or participate in family services.[35] The influence of community violence on home visiting retention has been demonstrated previously;[17] we hypothesized that it would have a similarly detrimental effect on prenatal engagement. Our analysis demonstrates a significant interaction between violence and race, such that increased violence confers a lower likelihood of early enrolment among white women, with a less pronounced effect for black women. Importantly, the observed finding of minimal influence of increased community violence on black maternal engagement may be accounted for by the fact that, as opposed to white women, the majority of black women in the sample reside in and are impacted by high-violence neighborhoods.

While further insight into agency and community factors may support a more comprehensive theory of home visiting, evaluation of such variables using retrospective analyses are unlikely to fully capture the complexity of issues surrounding program implementation. Prospective studies may be useful to more directly measure the effect of these factors. For example, quality improvement initiatives focused on early prenatal enrolment may promote standardization across agencies and elucidate specific best

practices. Targeted outreach by agencies to pregnant women in high-risk neighborhoods may also be important to overcome the effects of community violence on prenatal enrolment.

Limitations

Although we adjusted analyses for observable covariates, certain factors were unreliably documented or unavailable. In particular, the analysis of agency variables was limited to volume, while other predictors might include the breadth of other services offered, staff turnover and supervisory hours. Validation of findings in a larger population would be helpful in better characterizing the impact of race and referral source on prenatal enrolment patterns. Finally, generalizability is limited, given the regional population represented and our focus on HFA home visiting. Generalizability of findings is also limited to those participants enrolled in home visiting. Prior research has demonstrated potential selection bias in program enrolment based on differences in characteristics of women who were referred to home visiting but never enrolled. [18]

CONCLUSIONS

Prenatal home visiting enrolment represents a critical point of entry into preventative services. Most participants do not enroll by 20 weeks' gestation or receive the intended number of visits per the program curriculum. Service intensity is related to maternal, program and community factors. Since home visiting programs increasingly focus on birth outcomes, multiple opportunities exist to increase prenatal engagement.

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What is already known on this subject?

Several factors at the individual, program, and community level have been shown to influence enrollment and retention of at-risk families in home visiting. Prenatal engagement in particular may be a critical aspect of program effectiveness to address disparities in birth outcomes. Further research is needed that can identify opportunities to optimize engagement in prenatal home visiting services among at-risk, pregnant women.

What this study adds?

Low engagement in prenatal home visiting is common and is associated with young maternal age and lower education level. We observed significant variation in prenatal engagement based on clustering by agency, as well as by community of residence. Practice implications may include targeting interventions to enroll pregnant teenagers earlier, benchmarking and standardization of early prenatal enrolment across agencies, and an increasing agency outreach in high-risk communities.

Figure 1.

Conceptual model of how individual, agency and community factors may influence prenatal home visiting engagement. White text boxes represent different levels of predictors represented in the study, and black text box represents the outcome of maternal engagement in home visiting. Text with arrows describes proposed mechanisms of influence.

Figure 2.

Predicted probabilities of enrolment into home visiting by 20 weeks gestation by agency (A) and by community violence level (B). Y axis is the predicted probability of prenatal home visiting enrolment by 20 weeks gestation. In panel 1, the X axis represents each of eight unique home visiting agencies, and the dark grey bars indicate women aged <18 years, while the light grey bars indicate women who are aged ≥ 18 years. In panel 2, the X axis represents maternal race, categorized as White, Black and Other. The grey bars represent women residing in ZIP codes with violence rates below the sample mean (11/1000 residents); the white bars represent women residing in ZIP codes with violence rates above the sample mean. The error bars represent the 95% CIs for the predicted probabilities adjusted for other model parameters.

Table 1

Percent of women with enrolment by 20 weeks gestation and with high service intensity (enrolled 20 weeks and had 75% of expected visits) (N=837)

	Gestational age at enrollment		High service intensity	
	20 weeks	p-value	Enrolled 20 weeks and 75% of expected visits	p-value
Maternal race (%)		0.004		0.53
<i>White (n=245)</i>	33.1		8.9	
<i>Black (n=545)</i>	22.0		6.8	
<i>Other (n=47)</i>	23.4		6.4	
Hispanic ethnicity (%)		0.15		0.58
<i>Yes (n=39)</i>	15.4		5.1	
<i>no (n=798)</i>	25.8		7.5	
Maternal age (%)		0.05		0.55
<i>< 18 years (n=216)</i>	20.4		6.5	
<i>18 years (n=621)</i>	27.1		7.7	
Education level (%)		0.83		0.47
<i>High school not completed (n=451)</i>	25.5		8.4	
<i>High school completed (n=220)</i>	26.4		5.9	
<i>Above high school degree (n=165)</i>	23.6		6.7	
Marital status (%)		0.82		0.69
<i>Single (n=809)</i>	25.2		7.5	
<i>Married (n=23)</i>	30.4		4.4	
Smoker (%)		0.03		0.17
<i>Yes (n=272)</i>	30.2		9.2	
<i>no (n=565)</i>	23.0		6.6	
Hypertension (%)		0.11		0.02
<i>Yes (n=90)</i>	32.2		13.3	
<i>no (n=747)</i>	24.5		6.7	
Obesity (%)		0.48		0.88
<i>Yes (n=183)</i>	27.3		7.7	
<i>no (n=654)</i>	24.8		7.3	
Diabetes (%)		0.89		0.18
<i>Yes (n=49)</i>	24.5		12.2	
<i>no (n=788)</i>	25.4		7.1	
Previous poor birth outcome (%)		0.40		0.85
<i>Yes (n=101)</i>	28.7		6.9	
<i>no (n=736)</i>	24.9		7.5	
Referral source (%)		0.02		0.42
<i>Home visiting agency (n=175)</i>	33.7		9.7	

	Gestational age at enrollment		High service intensity			
	20 weeks	p-value	Enrolled	20 weeks and expected visits	75% of	p-value
<i>Prenatal clinic/hospital (n=507)</i>	22.7			6.7		
<i>Other community source (n=155)</i>	24.5			7.1		
Agency volume (%)		0.10				0.62
<i>>4,000 (Largest) (n=126)</i>	22.7			6.1		
<i>2,000–4,000 (Moderate to Large) (n=182)</i>	24.7			7.9		
<i>1,500–2,000 (Small to Moderate) (n=392)</i>	25.8			6.0		
<i>1,500 (Smallest) (n=132)</i>	34.9			9.5		
Community violence rate (%)		0.32				0.22
<i>11 violent injuries/1,000 residents (n=461)</i>	27.6			8.5		
<i>> 11 violent injuries/1,000 residents (n=371)</i>	24.5			6.2		

Table 2

Adjusted odds ratios of enrolment by 20 weeks gestation and high service intensity associated with maternal and agency-level factors (N=837)^a

	Adjusted odds ratio, enrollment 20 weeks (95% confidence interval)	Adjusted odds ratio, high service intensity (95% confidence interval)
Maternal race		
<i>Black</i>	0.91 (0.56–1.46)	1.15 (0.52–2.58)
<i>Other</i>	0.88 (0.38–2.05)	0.92 (0.22–3.90)
<i>White</i>	(reference)	(reference)
Maternal age < 18 years	0.58 (0.34–0.99)	0.62 (0.27–1.45)
Education level		
<i>Above high school degree</i>	1.45 (0.86–2.44)	1.51 (0.66–3.47)
<i>High school completed</i>	1.15 (0.68–1.95)	0.82 (0.33–2.10)
<i>High school not completed</i>	(reference)	(reference)
Smoker	1.19 (0.77–1.83)	1.24 (0.62–2.51)
Referral source		
<i>Home visiting agency</i>	1.39 (0.80–2.42)	1.27 (0.53–3.09)
<i>Prenatal clinic/hospital</i>	0.93 (0.57–1.51)	1.00 (0.45–2.22)
<i>Other community source</i>	(reference)	(reference)
Agency volume ^b		
<i>>4,000 (Largest)</i>	1.35 (0.18–10.10)	1.22 (0.10–14.57)
<i>2,000–4,000 (Moderate to Large)</i>	1.44 (0.26–7.87)	1.31 (0.15–11.62)
<i>1,500–2,000 (Small to Moderate)</i>	1.56 (0.25–9.63)	0.95 (0.09–9.91)
<i>1,500 (Smallest)</i>	(reference)	(reference)

^aRandom intercept multilevel model using a logit link function and binary distribution, adjusting for clustering by agency as a higher level effect.

^bAgency volume was tabulated as the average annual number of home visits completed

Table 3

Adjusted odds ratios of enrolment by 20 weeks and high service intensity associated with maternal predictors and community violence rates (N=832)^{a,b,c}

	Adjusted odds ratio, enrollment 20 weeks (95% confidence interval)	Adjusted odds ratio, high service intensity (95% confidence interval)
Maternal age < 18 years	0.49 (0.30–0.78)	0.44 (0.21–0.96)
Education level		
<i>Above high school degree</i>	1.86 (1.13–3.07)	2.62 (1.14–6.06)
<i>High school completed</i>	1.60 (0.96–2.67)	1.24 (0.50–3.07)
<i>High school not completed</i>	(reference)	(reference)
Smoker	1.36 (0.93–1.99)	–
Referral source		
<i>Home visiting agency</i>	1.98 (1.15–3.41)	–
<i>Prenatal clinic/hospital</i>	1.17 (0.72–1.91)	–
<i>Other community source</i>	(reference)	–
Hypertension	–	2.81 (1.32–5.98)
Maternal race – Violent injury interaction ^d		
<i>White race*injury rate</i>	0.79 (0.68–0.93)	0.43 (0.23–0.80)
<i>Black race*injury rate</i>	0.95 (0.86–1.05)	0.94 (0.80–1.10)
<i>Other race*injury rate</i>	1.23 (0.94–1.60)	1.17 (0.79–1.74)

^aRandom intercept multilevel model using a logit link function and binary distribution, adjusting for clustering by ZIP code as a random effects parameter. Some observations were omitted due to small cluster sizes (ZIP code containing less than 10 participants).

^bBolded values represent statistical significance with p-values < 0.05

^cCells with dashes indicate omission of the variable from the multivariable analysis to maintain due to lack of significance and to maintain model parsimony

^dViolent injury (e.g., assault, homicide) count per 1,000 residents by ZIP code; point estimates reflect the odds ratio associated with a 2-unit increase in this rate for each maternal race group