A Statewide Medicaid Enhanced Prenatal Care Program Impact on Birth Outcomes

LeeAnne Roman, MSN, PhD; Jennifer E. Raffo, MA; Qi Zhu, MS; Cristian I. Meghea, PhD

IMPORTANCE Policy makers and practitioners need rigorous evaluations of state-based Medicaid enhanced prenatal care programs that provide home visiting to guide improvements and inform future investments. Effects on adverse birth outcomes are of particular interest.

OBJECTIVE To test if participation in the Michigan statewide enhanced prenatal care program, the Maternal Infant Health Program (MIHP), accounting for program timing and dosage, reduced risk for low birth weight (LBW) and preterm birth, particularly among black women who are at greater risk for adverse outcomes.

DESIGN, SETTING, AND PARTICIPANTS Quasi-experimental cohort study. Data, including birth records, Medicaid claims, and monthly program participation, were extracted from the Michigan Department of Community Health warehouse. Participants included all 60,653 pregnant women who had a Medicaid-insured singleton birth between January 1 and December 31, 2010, in Michigan. The MIHP participants were propensity score-matched with nonparticipants based on demographics, previous pregnancies, socioeconomic status, and chronic disease.

EXPOSURE An enhanced prenatal care program.

MAIN OUTCOMES AND MEASURES Low birth weight, very low birth weight (VLBW), preterm birth, and very preterm birth.

RESULTS In the propensity score-matched models, black women who enrolled and were screened in the MIHP by the end of the second trimester had lower odds of VLBW (odds ratio [OR], 0.76; 95% CI, 0.59-0.97) and very preterm births (OR, 0.68; 95% CI, 0.54-0.85) than matched nonparticipants. Black MIHP participants who enrolled and were screened in the program by the second trimester and had at least 3 additional prenatal MIHP contacts had lower odds of LBW (OR, 0.76; 95% CI, 0.65-0.89), VLBW (OR, 0.42; 0.30-0.61), preterm birth (OR, 0.71; 0.61-0.83), and very preterm birth (OR, 0.41; 0.30-0.57) compared with matched nonparticipants. The MIHP participants of other races and ethnicities who enrolled and were screened in the program by the second trimester and had at least 3 additional prenatal MIHP contacts had lower odds of LBW (OR, 0.78; 95% CI, 0.66-0.93), VLBW (OR, 0.38; 0.22-0.66), preterm birth (OR, 0.77; 0.66-0.89), and very preterm birth (OR, 0.63; 0.43-0.91) compared with matched nonparticipants.

CONCLUSIONS AND RELEVANCE Participation in MIHP reduced the risk for adverse birth outcomes in a diverse, disadvantaged population. The study adds to the evidence base for enhanced prenatal care home visiting programs and informs state and federal investments.


Research

Original Investigation

A Statewide Medicaid Enhanced Prenatal Care Program Impact on Birth Outcomes

LeeAnne Roman, MSN, PhD; Jennifer E. Raffo, MA; Qi Zhu, MS; Cristian I. Meghea, PhD

IMPORTANCE Policy makers and practitioners need rigorous evaluations of state-based Medicaid enhanced prenatal care programs that provide home visiting to guide improvements and inform future investments. Effects on adverse birth outcomes are of particular interest.

OBJECTIVE To test if participation in the Michigan statewide enhanced prenatal care program, the Maternal Infant Health Program (MIHP), accounting for program timing and dosage, reduced risk for low birth weight (LBW) and preterm birth, particularly among black women who are at greater risk for adverse outcomes.

DESIGN, SETTING, AND PARTICIPANTS Quasi-experimental cohort study. Data, including birth records, Medicaid claims, and monthly program participation, were extracted from the Michigan Department of Community Health warehouse. Participants included all 60,653 pregnant women who had a Medicaid-insured singleton birth between January 1 and December 31, 2010, in Michigan. The MIHP participants were propensity score-matched with nonparticipants based on demographics, previous pregnancies, socioeconomic status, and chronic disease.

EXPOSURE An enhanced prenatal care program.

MAIN OUTCOMES AND MEASURES Low birth weight, very low birth weight (VLBW), preterm birth, and very preterm birth.

RESULTS In the propensity score-matched models, black women who enrolled and were screened in the MIHP by the end of the second trimester had lower odds of VLBW (odds ratio [OR], 0.76; 95% CI, 0.59-0.97) and very preterm births (OR, 0.68; 95% CI, 0.54-0.85) than matched nonparticipants. Black MIHP participants who enrolled and were screened in the program by the second trimester and had at least 3 additional prenatal MIHP contacts had lower odds of LBW (OR, 0.76; 95% CI, 0.65-0.89), VLBW (OR, 0.42; 0.30-0.61), preterm birth (OR, 0.71; 0.61-0.83), and very preterm birth (OR, 0.41; 0.30-0.57) compared with matched nonparticipants. The MIHP participants of other races and ethnicities who enrolled and were screened in the program by the second trimester and had at least 3 additional prenatal MIHP contacts had lower odds of LBW (OR, 0.78; 95% CI, 0.66-0.93), VLBW (OR, 0.38; 0.22-0.66), preterm birth (OR, 0.77; 0.66-0.89), and very preterm birth (OR, 0.63; 0.43-0.91) compared with matched nonparticipants.

CONCLUSIONS AND RELEVANCE Participation in MIHP reduced the risk for adverse birth outcomes in a diverse, disadvantaged population. The study adds to the evidence base for enhanced prenatal care home visiting programs and informs state and federal investments.

Given federal and state investments in prenatal and early childhood home visiting programs, there are renewed calls for evidence of the effectiveness of these programs. Medicaid, covering more than 40% of all US births, has historically made substantial investments in prenatal home visiting by providing matching funds to states through enhanced prenatal care (EPC) programs. The EPC programs serve low-income pregnant women who are especially burdened with psychosocial stressors, have more health and social problems, have difficulties using services, and are at greater risk for adverse birth outcomes. These programs typically include care coordination, psychosocial support, and health education to help women have healthy pregnancies and improve infant and maternal health.

Previous evaluations of state-sponsored EPC programs have shown mixed effects for improvement in birth outcomes. Most studies have methodologic limitations, including failing to account for program selection bias or the dosage of services. Randomized controlled trials of targeted home visiting programs, with few exceptions, have typically not found improved birth outcomes. Regardless, trials are not feasible for EPC programs with Medicaid population-based eligibility serving women with varying levels of risk, need for services, and readiness to engage in services.

Policy makers and practitioners need rigorous evaluations of state-based EPC programs to guide program improvements and inform investment decisions. Furthermore, eligibility for new home visiting funding, authorized under the Patient Protection and Affordable Care Act, will require testability for new home visiting funding, authorized under the Patient Protection and Affordable Care Act of 2010 (PPACA), will require testability for new home visiting funding, authorized under the PPACA, will require testability for new home visiting funding, authorized under the PPACA.

Methods

Study Design and Population

This study used a quasi-experimental design to compare the birth outcomes of women in MIHP with a matched comparison group from among the Medicaid-insured women who did not participate in MIHP. The cohort consisted of all women who had a Medicaid-insured singleton birth between January 1 and December 31, 2010, in Michigan (N = 60,653). Data, available through the Michigan Department of Community Health warehouse, consisted of all Medicaid maternal medical claims during pregnancy, monthly Medicaid eligibility from 3 months before conception through birth, and other program participation data (such as cash assistance) linked to infant birth records based on unique Michigan Department of Community Health Master Record Numbers. Prenatal MIHP risk screening data were also linked to the data set. The study received approval by the Michigan State University Institutional Review Board.

Variables

Outcomes

Birth outcomes, defined as binary indicators, included (1) low birth weight (LBW), defined as less than 2500 g reported on the birth certificate; (2) preterm birth, described as delivery before 37 completed weeks’ gestation based on the last menstrual period self-reported on the birth certificate; (3) very low birth weight (VLBW), established as less than 1500 g reported on the birth certificate; and (4) very preterm birth, defined as delivery before 32 completed weeks’ gestation.

MIHP Participation

An MIHP participation indicator was coded “yes” if at least 1 maternal claim with MIHP Current Procedural Terminology or Healthcare Common Procedure Coding System codes submitted by an MIHP provider was present during pregnancy or an MIHP prenatal screener record was identified; otherwise, it was coded “no.” When estimating the effects of MIHP participation, we excluded from the preterm birth and very preterm birth analyses women who enrolled in MIHP after the outcome threshold, 37 and 32 weeks’ gestation, respectively. To capture the effects of MIHP enrollment timing, a second MIHP participation indicator was coded 1 if women enrolled in MIHP in the first or second trimester and 0 if not participating in the program. This is consistent with a trial study that found greater improvements in birth outcomes for women enrolled in the first 2 trimesters. We excluded women who enrolled in MIHP in the third trimester since exploratory analyses indicated progressively decreased preterm birth rates for those recruited closer to full term. This was likely the result of inherently being
further along in the pregnancy and more likely to carry the pregnancy to term and not an MIHP effect. A third MIHP participation dosage indicator was coded 1 if women enrolled in MIHP and were screened in the first or second trimester and had at least 3 additional MIHP contacts during pregnancy and 0 if not participating in MIHP, consistent with other studies that use or show a dosage effect.\textsuperscript{28,39}

Matching Maternal Baseline Characteristics
Maternal age, marital status, race and ethnicity, county of residence, prenatal smoking, first-time pregnancy, and rapid repeat pregnancy within 18 months and 2 socioeconomic status measures were included. The first binary indicator identified pregnant women at or below the 33\% federal poverty level (FPL) based on their participation in the Low-Income Family Program and receipt of cash assistance. The second binary indicator distinguished between women who had Medicaid before pregnancy (income up to 63\% FPL if older than 19 years), which describes most participants in our study, and up to 150\% if 19 years or younger) and higher-income women who became Medicaid eligible after confirming the pregnancy, with income up to 185\% FPL regardless of age.\textsuperscript{5} Three binary indicators for maternal chronic conditions were also included, coded 1 if related claims during pregnancy were present based on diagnostics and procedure codes and 0 otherwise. To minimize the possibility of measurement error, including potential disease onset after MIHP program enrollment during pregnancy, we considered the most prevalent conditions defined using \textit{International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)} codes: asthma (\textit{ICD-9-CM} codes 491-493), diabetes mellitus (\textit{ICD-9-CM} code 250), and hypertension (\textit{ICD-9-CM} codes 401-405).

Statistical Analysis
Women enrolled in MIHP were compared with all women not enrolled in the program (Table 1). The probability of MIHP participation (the propensity score) was then estimated for the entire cohort as a function of all baseline characteristics using logistic regression.\textsuperscript{40,41} Estimations were performed separately for black women and for women of other races and ethnicities. A one-to-one matched control group from among the nonparticipants was selected. After random sorting of the propensity scores, the nearest-neighbor matching method without replacement on a Mahalanobis distance with a caliper of 0.2 SD, within the same race (black vs others), was used.\textsuperscript{42} Bivariate conditional logistic regression analyses were performed to assess baseline equivalence between the MIHP participants and the matched comparison group (Table 2). Propensity score models were adjusted, including considering interactions, higher-order terms, and multiple matches, to ensure maximum balance on baseline covariates.\textsuperscript{40,43} Using the individual county of residence (vs state regions) as a baseline covariate minimized the number of duplicate propensity scores. The MIHP enrolled 18 798 pregnant clients who had a singleton birth in 2010. Using the first MIHP definition, the reported propensity score analysis retained more than 85\% of the MIHP clients in the analyses matched with nonparticipants. The other 15\% were excluded due to missing relevant baseline data or because a match was not found within the caliper (Table 2, columns 1-2). The matching process yielded more

### Table 1. Baseline Comparisons: MIHP Participants vs All Nonparticipants\textsuperscript{a}

<table>
<thead>
<tr>
<th>Characteristic (Covariate)</th>
<th>All Singleton Medicaid-Eligible Births (n = 60 653)</th>
<th>MIHP Participants (n = 18 762)</th>
<th>All Nonparticipants (n = 41 891)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean, y</td>
<td>26.3</td>
<td>25.3\textsuperscript{a}</td>
<td>26.7</td>
</tr>
<tr>
<td>Race or ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>61.6</td>
<td>51.2\textsuperscript{b}</td>
<td>65.9</td>
</tr>
<tr>
<td>Black</td>
<td>27.7</td>
<td>38.0\textsuperscript{b}</td>
<td>23.4</td>
</tr>
<tr>
<td>Hispanic</td>
<td>6.5</td>
<td>7.3\textsuperscript{b}</td>
<td>6.0</td>
</tr>
<tr>
<td>Other</td>
<td>4.2</td>
<td>3.0\textsuperscript{b}</td>
<td>4.7</td>
</tr>
<tr>
<td>Income ≤33% FPL\textsuperscript{c}</td>
<td>12.8</td>
<td>17.9\textsuperscript{b}</td>
<td>10.7</td>
</tr>
<tr>
<td>Medicaid before pregnancy, income ≤63%-150% FPL\textsuperscript{d}</td>
<td>56.8</td>
<td>65.6\textsuperscript{b}</td>
<td>53.2</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>34.2</td>
<td>33.2\textsuperscript{b}</td>
<td>21.9</td>
</tr>
<tr>
<td>Mother only on birth certificate</td>
<td>25.2</td>
<td>24.1\textsuperscript{b}</td>
<td>38.5</td>
</tr>
<tr>
<td>Not married, paternity acknowledged</td>
<td>40.6</td>
<td>42.7\textsuperscript{b}</td>
<td>39.7</td>
</tr>
<tr>
<td>Prenatal smoking</td>
<td>29.7</td>
<td>30.6\textsuperscript{b}</td>
<td>28.4</td>
</tr>
<tr>
<td>Rapid repeat pregnancy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;18 mo from previous pregnancy</td>
<td>26.0</td>
<td>24.7\textsuperscript{b}</td>
<td>26.6</td>
</tr>
<tr>
<td>≥18 mo from previous pregnancy</td>
<td>35.6</td>
<td>31.7\textsuperscript{b}</td>
<td>37.2</td>
</tr>
<tr>
<td>First pregnancy</td>
<td>33.8</td>
<td>39.3\textsuperscript{b}</td>
<td>31.5</td>
</tr>
<tr>
<td>Unknown</td>
<td>4.6</td>
<td>4.6\textsuperscript{b}</td>
<td>4.7</td>
</tr>
<tr>
<td>Asthma</td>
<td>11.3</td>
<td>15.3\textsuperscript{b}</td>
<td>9.7</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>3.7</td>
<td>4.6\textsuperscript{b}</td>
<td>3.3</td>
</tr>
<tr>
<td>Hypertension</td>
<td>4.2</td>
<td>5.5\textsuperscript{b}</td>
<td>3.7</td>
</tr>
</tbody>
</table>

Abbreviations: FPL, federal poverty level; MIHP, (Michigan) Maternal Infant Health Program.
\textsuperscript{a} Values are presented as percentages unless otherwise indicated.
\textsuperscript{b} Statistically significant differences (P < .05) between MIHP prenatal participants and all Medicaid-eligible pregnant women not in MIHP. There were no statistically significant differences between MIHP prenatal participants and the matched comparison group.
\textsuperscript{c} Binary indicator: a pregnant woman at or below 33\% FPL based on her participation in the Low-Income Family Program and receipt of cash assistance.
\textsuperscript{d} Binary indicator: a Medicaid-eligible pregnant woman who had Medicaid before the pregnancy (qualifying income ≤63\% FPL if aged >19 years [which describes most participants in the current study] and ≤150\% FPL if aged ≤19 years).
Table 2. Baseline Equivalence: MIHP Participants vs the Propensity Score–Matched Comparison Group

<table>
<thead>
<tr>
<th>Characteristic (Covariate)</th>
<th>MIHP (n = 16 044)</th>
<th>No MIHP (n = 16 044)</th>
<th>MIHP First or Second Trimester Enrollment (n = 12 375)</th>
<th>No MIHP First or Second Trimester Enrollment (n = 12 375)</th>
<th>MIHP First or Second Trimester Enrollment and &gt;3 Total Contacts (n = 7 664)</th>
<th>No MIHP First or Second Trimester Enrollment and &gt;3 Total Contacts (n = 7 664)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean, y</td>
<td>25.5</td>
<td>25.5</td>
<td>25.5</td>
<td>25.5</td>
<td>25.3</td>
<td>25.4</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>51.0</td>
<td>51.5</td>
<td>51.0</td>
<td>51.6</td>
<td>48.8</td>
<td>48.4</td>
</tr>
<tr>
<td>Black</td>
<td>38.6</td>
<td>38.6</td>
<td>38.2</td>
<td>38.2</td>
<td>40.0</td>
<td>40.0</td>
</tr>
<tr>
<td>Hispanic</td>
<td>7.4</td>
<td>7.2</td>
<td>7.9</td>
<td>7.5</td>
<td>8.3</td>
<td>8.7</td>
</tr>
<tr>
<td>Other</td>
<td>3.1</td>
<td>2.8</td>
<td>3.0</td>
<td>2.8</td>
<td>3.0</td>
<td>2.9</td>
</tr>
<tr>
<td>Income ≤33% FPLb</td>
<td>16.8</td>
<td>16.6</td>
<td>18.2</td>
<td>18.3</td>
<td>19.2</td>
<td>19.2</td>
</tr>
<tr>
<td>Medicaid before pregnancy, income ≤63%-150% FPLc</td>
<td>63.0</td>
<td>62.8</td>
<td>68.9</td>
<td>69.4</td>
<td>71.1</td>
<td>71.1</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>25.2</td>
<td>24.3</td>
<td>25.1</td>
<td>23.8</td>
<td>23.9</td>
<td>23.0</td>
</tr>
<tr>
<td>Mother only on birth certificate</td>
<td>32.4</td>
<td>32.7</td>
<td>31.9</td>
<td>32.6</td>
<td>33.6</td>
<td>34.2</td>
</tr>
<tr>
<td>Not married, paternity acknowledged</td>
<td>42.4</td>
<td>42.9</td>
<td>43.0</td>
<td>43.6</td>
<td>42.5</td>
<td>42.8</td>
</tr>
<tr>
<td>Prenatal smoking</td>
<td>30.6</td>
<td>30.5</td>
<td>31.5</td>
<td>32.3</td>
<td>31.6</td>
<td>31.6</td>
</tr>
<tr>
<td>Rapid repeat pregnancy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;18 mo from previous pregnancy</td>
<td>25.3</td>
<td>25.6</td>
<td>25.5</td>
<td>26.0</td>
<td>24.4</td>
<td>24.3</td>
</tr>
<tr>
<td>≥18 mo from previous pregnancy</td>
<td>32.5</td>
<td>32.9</td>
<td>33.1</td>
<td>33.9</td>
<td>31.6</td>
<td>32.4</td>
</tr>
<tr>
<td>First pregnancy</td>
<td>37.6</td>
<td>37.0</td>
<td>37.1</td>
<td>36.0</td>
<td>39.7</td>
<td>39.3</td>
</tr>
<tr>
<td>Unknown</td>
<td>4.6</td>
<td>4.5</td>
<td>4.3</td>
<td>4.1</td>
<td>4.4</td>
<td>4.1</td>
</tr>
<tr>
<td>Asthma</td>
<td>13.5</td>
<td>13.0</td>
<td>14.6</td>
<td>14.3</td>
<td>16.5</td>
<td>15.8</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>4.1</td>
<td>3.8</td>
<td>4.4</td>
<td>4.1</td>
<td>4.6</td>
<td>4.0</td>
</tr>
<tr>
<td>Hypertension</td>
<td>5.0</td>
<td>4.8</td>
<td>5.4</td>
<td>5.2</td>
<td>5.9</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Abbreviations: FPL, federal poverty level; MIHP, (Michigan) Maternal Infant Health Program.

* Values are presented as percentages unless otherwise indicated.

b Binary indicator: a Medicaid-eligible pregnant woman who had Medicaid before the pregnancy qualifying income ≤63% FPL if aged >19 years (which describes most participants in the current study) and ≤150% FPL if aged ≤19 years.

c Binary indicator: a pregnant woman at or below 33% FPL based on her participation in the Low-Income Family Program and receipt of cash assistance.

Results

There were 60,653 Medicaid-insured singleton births in Michigan during 2010, with both mother and newborn insured by Medicaid at birth; approximately 30% (n = 18,762) of the mothers participated in the MIHP during pregnancy. There were significant differences among all the baseline characteristics between MIHP participants and the women who did not participate in the program (Table 1). More women in MIHP identified as black (38.0% vs 23.4%), were first-time mothers (39.3% vs 31.5%), had a family income at or below 33% FPL (17.9% vs

than a 99% propensity score overlap between the MIHP group and the matched comparison group. The aforementioned analyses were separately estimated for each of the 3 MIHP definitions, including propensity score estimations and matching. Table 2 reports the baseline equivalence using all 3 MIHP definitions.

Table 3 presents the prevalence of outcomes in the matched samples of interest. There were 0.04% observations with missing data in the birth weight and 5% with missing data in the completed weeks’ gestation, which were omitted from the analyses. To test the hypothesis of MIHP having favorable effects on birth outcomes, we compared MIHP participants, applying the 3 alternative MIHP definitions, with matched comparison groups using conditional logistic regressions adjusted for the county of residence. Odds ratios (ORs) and 95% CIs were reported (Table 4). We performed analyses with women of all races and separately for black women and women of other races.

Unobserved variables simultaneously affecting the treatment assignment and the outcomes may generate a “hidden bias” to which matching estimators may not be robust.44,45 The bounding approach proposed by Rosenbaum determines how strongly an unmeasured variable must influence the selection into MIHP to invalidate our birth outcome results.44,45 We calculated how much larger than 1 (OR = 1 is the assumption of no hidden bias) would the odds of MIHP exposure need to be for our findings to lose statistical significance if there was a negative unobserved MIHP selection (Table 5). SAS, version 9.1.3 (SAS Institute), and Stata, version 11 (StataCorp LP), were used to perform the analyses.

Table 3. Prevalence of Outcomes in the Matched Samples of Interest

<table>
<thead>
<tr>
<th>Outcome</th>
<th>MIHP (n = 16 044)</th>
<th>No MIHP (n = 16 044)</th>
<th>MIHP First or Second Trimester Enrollment (n = 12 375)</th>
<th>No MIHP First or Second Trimester Enrollment (n = 12 375)</th>
<th>MIHP First or Second Trimester Enrollment and &gt;3 Total Contacts (n = 7 664)</th>
<th>No MIHP First or Second Trimester Enrollment and &gt;3 Total Contacts (n = 7 664)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight (g)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>0.04%</td>
<td>0.04%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birth weight</td>
<td>2978±246</td>
<td>2978±246</td>
<td>2978±246</td>
<td>2978±246</td>
<td>2978±246</td>
<td>2978±246</td>
</tr>
<tr>
<td>Gestational age (weeks)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>5%</td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gestational age</td>
<td>38±0</td>
<td>38±0</td>
<td>38±0</td>
<td>38±0</td>
<td>38±0</td>
<td>38±0</td>
</tr>
</tbody>
</table>

Abbreviations: MIHP, (Michigan) Maternal Infant Health Program.

a Values are presented as percentages unless otherwise indicated.

b Binary indicator: a pregnant woman at or below 33% FPL based on her participation in the Low-Income Family Program and receipt of cash assistance.

c Binary indicator: a Medicaid-eligible pregnant woman who had Medicaid before the pregnancy qualifying income ≤63% FPL if aged >19 years (which describes most participants in the current study) and ≤150% FPL if aged ≤19 years.

Jama pediatrics.com
In general, the prevalence of LBW, VLBW, preterm births, and very preterm births was lower among the women in MIHP compared with the matched control groups (Table 3). Women who participated in MIHP during pregnancy had lower odds of LBW (OR, 0.86; 95% CI, 0.78-0.97), VLBW (0.70; 0.56-0.88), preterm births (0.85; 0.76-0.94), and very preterm births (0.68; 0.54-0.85). All results were statistically significant at the 95% level (Table 4, I). When considering women who enrolled in MIHP by the end of the second trimester, thus excluding late-enrolled women who were also less likely to deliver early, significant program-control differences were limited to VLBW (OR, 0.76; 95% CI, 0.59-0.97) and very preterm births (0.68; 0.54-0.85) for black participants (Table 4, II).

When comparing MIHP participants who enrolled in the program by the second trimester and who were screened for prenatal risk with at least 3 additional MIHP contacts with matched nonparticipants, we found significant risk reduction among black women and women of other races (Table 4, III). Participation in MIHP lowered the overall odds of LBW (OR, 0.77; 95% CI, 0.69-0.87), VLBW (0.41: 0.31-0.56), preterm births (0.74; 0.67-0.82), and very preterm births (0.49; 0.38-0.62) among black women and women of other races compared with the matched nonparticipants. Women who participated in MIHP during pregnancy had lower odds of LBW (OR, 0.91; 95% CI, 0.84-0.98), VLBW (0.71; 0.59-0.86), preterm births (0.80; 0.68-0.95), and very preterm births (0.54-0.85) than matched nonparticipants (Table 4, I). Among black women, MIHP participants had lower odds of LBW (OR, 0.91; 95% CI, 0.84-0.98), VLBW (0.71; 0.59-0.86), preterm births (0.85; 0.76-0.94), and very preterm births (0.68; 0.54-0.85) than matched nonparticipants (Table 4, I).
0.38-0.62). The reductions in the odds of preterm births (OR, 0.71; 95% CI, 0.61-0.83) and very preterm births (0.41; 0.30-0.57) were larger among black women.

Unobserved characteristics would have to cause differences in the odds of treatment assignment between the MIHP group and the control group with an OR as high as 1.7 to invalidate the favorable MIHP effects on VLBW and an OR of 1.92 for very preterm births among black women enrolled and screened in the first 2 trimesters and with more than 3 additional contacts, indicating robustness of the MIHP effects (Table 5).

**Discussion**

For black women who enrolled in the program by the end of the second trimester, participation decreased the odds of having an extreme adverse birth outcome, specifically VLBW and very preterm births. Enrolling in the program in the first 2 trimesters and receiving screening and at least 3 additional face-to-face prenatal contacts decreased the odds of having adverse birth outcomes—LBW, VLBW, preterm births, and very preterm births—for women of all races, with the MIHP effects on VLBW and very preterm births for black women less sensitive to potential unobserved confounders.

Our results are consistent with several randomized controlled trial evaluations that found participation in prenatal home visiting programs had positive effects on birth weight and stronger effects for women enrolled in the first trimester and for black women.\textsuperscript{29,30} These studies found no program effect on reducing prematurity. Cooper and colleagues\textsuperscript{46} used propensity score matching in an urban population and found that participation in a federal Healthy Start home visiting program significantly reduced the odds of LBW (OR, 0.28) and prematurity (OR, 0.25). However, the study relied on a small sample size (84 in the intervention group), limited matching characteristics, and did not account for timing and dosage of services.

Our study methods limit comparison with many studies of Medicaid state-sponsored EPC programs. Most state program evaluations were observational and had limitations, including selection bias and lack of timing and dosage of services.\textsuperscript{17-27} Slaughter and colleagues\textsuperscript{28} addressed some of these limitations by using propensity score–adjusted regression analysis to evaluate the Iowa prenatal care management program. The study found that receiving a moderate (1-3 contacts) to high (>3 contacts) amount of prenatal care management contacts decreased the odds of having a LBW or preterm birth in non-Hispanic white women.

Our MIHP evaluation had several strengths. First, the quasi-experimental propensity score–matching design was rigorous, accounting for potential bias and dosage of services. Second, our study population was a statewide birth cohort of Medicaid-insured infants and their mothers. Since the Michigan population is racially heterogeneous, including rural and large metropolitan areas, our results are generalizable. Third, we included analyses of the robustness of our findings to the possibility of hidden bias due to unobserved selection factors. Finally, the realization that late-enrolled women were more likely to carry the pregnancy past the very preterm and preterm births, as well as the resulting exclusions, avoided the overestimation of program effects.

Several limitations are noted. We used an analysis that balanced on selection factors expected to influence participation in MIHP, yet, as with other observational studies, our matching was limited to observable characteristics documented in our data. Other selection factors potentially unmeasured may affect our findings. For example, women who enroll in MIHP may have higher psychosocial resources and greater readiness to engage in services. Another notable unavailable characteristic was maternal education, not present in the limited version of the birth certificate data available through the Michigan Department of Community Health warehouse (our data source). For selected adverse birth outcomes, however, the extent of bias induced by potential unobserved selection factors needs to be large to invalidate our favorable MIHP findings. Another potential limitation is the approximate 15% observations lost in the matching process. While not uncommon, it could bias our results if the lost observations were not a random sample.\textsuperscript{47} Women receiving our proposed dosage of contacts could be a selected subgroup with longer pregnancies. However, more than 96% of the women with this MIHP dosage receive at least 3 additional visits before 37 completed pregnancy weeks, close to 85% by 32 weeks, and close to 70% by 28 weeks’ gestation, limiting the potential overestimation of the MIHP effects.

### Table 5. Sensitivity Analyses for Selected MIHP Favorable Effects

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Required Hidden Bias, OR*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(I) All in MIHP vs Matched Non-MIHP</td>
</tr>
<tr>
<td></td>
<td>All Races (n = 32,088)</td>
</tr>
<tr>
<td>LBW</td>
<td>1.04</td>
</tr>
<tr>
<td>VLBW</td>
<td>1.17</td>
</tr>
<tr>
<td>Preterm</td>
<td>1.04</td>
</tr>
<tr>
<td>Very preterm</td>
<td>1.08</td>
</tr>
</tbody>
</table>

Abbreviations: LBW, low birth weight; MIHP, (Michigan) Maternal Infant Health Program, NC, not calculated; OR, odds ratio; VLBW, very low birth weight.

* The threshold ORs of difference in MIHP assignment between the MIHP and the matched control group in order for MIHP favorable results to lose significance. Higher OR implies robustness of results to potential hidden bias.
Our findings should be interpreted with caution, and we acknowledge that birth weight and gestational age are the result of a broad range of social, psychological, behavioral, and biological influences, many interdependent and poorly understood. However, the program addresses risk factors that have been shown to affect fetal growth such as inadequate maternal weight gain during pregnancy, excessive alcohol use, and prenatal smoking. Smoking cessation has also been shown to have small effects on reducing the rate of preterm birth. Although the program addresses other risk factors such as chronic illness, depression, social support, and stress, the literature is mixed about how these factors influence birth outcomes. Our data sources limit the identification of the content of MIHP contacts and whether specific risks were resolved, information that could be used to better understand the potential mechanisms of program effects. Future studies will address these limitations since MIHP now requires electronic reporting of prenatal service content and specific risk reductions.

Conclusions

Our findings suggest that a state Medicaid-sponsored population-based EPC program reduced risk for adverse birth outcomes, with particular advantage for black women. Since socioeconomic and racial and ethnic disparities in adverse birth outcomes persist, reducing risk in Medicaid-insured pregnant women is an important public health goal. Our results are relevant given federal efforts to improve EPC and home visiting, drawing attention to the value of existing statewide prenatal home visiting programs and infrastructures that can be strengthened to deliver evidence-based interventions.

ARTICLE INFORMATION

Accepted for Publication: September 5, 2013.

Author Contributions: Dr Meghea had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Roman, Raffo, Meghea.
Acquisition of data: Roman, Zhu, Meghea.
Analysis and interpretation of data: All authors.
Drafting of the manuscript: All authors.
Critical revision of the manuscript for important intellectual content: Roman, Raffo, Meghea.
Statistical analysis: Raffo, Zhu, Meghea.
Obtained funding: Roman, Meghea.
Administrative, technical, or material support: Raffo.
Study supervision: Meghea.

Conflict of Interest Disclosures: None reported.

Funding/Support: This study was supported in part by the Michigan Department of Community Health.

Role of the Sponsor: The funding source had no role in the design and conduct of the study; collection, management, analysis, or interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Additional Contributions: Joseph Gardiner, PhD, and Zhehui Luo, PhD, provided advice on the propensity score-matching method, reviewed findings, and provided critical review during manuscript preparation; Claudia Holzman, DVM, MPH, PhD, provided advice on preterm birth and low birth weight and critical review during manuscript preparation. Drs Gardiner, Luo, and Holzman did not receive any financial compensation for their work.

REFERENCES

Medicaid Enhanced Prenatal Care Program


