

A Quasi-Experimental Population-Based Evaluation of the Michigan Maternal Infant Health Program

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A Quasi-Experimental Evaluation of the Michigan Maternal Infant Health Program - Executive Summary, February 2015 -

The Maternal Infant Health Program (MIHP) is a well-established population-based home visiting program available to all Medicaid-eligible pregnant women and infants up to age one in Michigan. The MIHP supports healthy pregnancies, positive birth outcomes, and healthy infants.

Michigan State University, at the request of the Michigan Department of Health and Human Services, is performing an independent evidence-based evaluation of MIHP effectiveness. A randomized trial was not feasible as Medicaid is an entitlement program and all insured pregnant women and infants are eligible for MIHP. As a rigorous alternative, a multi-method research approach including a quasi-experimental matched comparison design was used to evaluate MIHP.

This report summarizes the MIHP quasi-experimental evaluation research program to date. Maternal Infant Health Program (MIHP) was established as an evidence-based program through peer-reviewed publications in scientific journals. Building on the prior MIHP evaluation work, this report finds that MIHP sustained favorable effects in a fourth consecutive statewide birth cohort, with increased MIHP benefits among those enrolled early and receiving a dosage of services, provides additional details on the favorable impact on infant mortality, and presents favorable effects in three very different subpopulations. Complementing the quasi-experimental analyses, new investigations this year confirmed the favorable MIHP effects across the entire range of maternal and infant care and health outcomes when accounting for a significantly expanded set of participant-nonparticipant differences in screened risks at enrollment.

MIHP meets the DHHS federal criteria for an evidence-based home visiting program through 3 published manuscripts in peer-reviewed research journals. An additional manuscript is under consideration for publication, and 4 manuscripts are under preparation and will be submitted for publication in peer-reviewed research journals.

MIHP participation has favorable effects on:

- **Prenatal Care:** MIHP participation increased the likelihood of receiving prenatal care and improved the prenatal care adequacy.

- **Birth Outcomes:** Participation in MIHP reduced risks of prematurity, extreme prematurity, low birth weight, and very low birth weight.
- **Maternal Postnatal Care:** MIHP participation increased the likelihood of mothers receiving an appropriate postnatal checkup. Eligible mothers enrolled in MIHP during pregnancy were more likely to enroll in the Plan First! family planning program after birth.¹
- **Infant health care:** Participation in MIHP increased the likelihood for infants to present for any well-child visits and of receiving the appropriate number of well-child visits during the first year of life.
- **Infant mortality:** Participation in MIHP reduced risk of infant mortality. The favorable effects were present both among Black infants and among infants of other races and were robust in reducing neonatal mortality. Possible mechanisms include improvements in the adequacy of prenatal care and reductions in the risk of adverse birth outcomes, consistent with neonatal effects.

Positive MIHP effects were sustained in four successive statewide birth cohorts. There was a continued pattern of significant favorable effects across a range of maternal and infant care and health outcomes during pregnancy, at birth, and through the first year after birth. The effects were broader and more pronounced among participants who enrolled early during pregnancy and received a dosage of prenatal MIHP services. The quasi-experimental matched analyses confirmed the statewide MIHP wide range of MIHP favorable effects in three subpopulations: Detroit's Wayne County (large Black population), the Detroit metro tri-county area (Wayne, Oakland and Macomb) and Michigan's Upper Peninsula (large White population, mostly rural). The favorable MIHP effects were sustained in analyses that accounted for an expanded set of screened risk factors that were different between those who received additional MIHP services and those screened-only. Similar to other programs, more infant injury visits were found among MIHP participants, mostly explained by more superficial injuries. A positive finding was that MIHP infants seemed to have fewer poisoning episodes, a more severe occurrence. These findings further support the evidence-based effectiveness of MIHP as a population management home visiting program. The MIHP quasi-experimental evaluation research program continues.

¹ Plan First! new enrollment closed April 1, 2014

A QUASI-EXPERIMENTAL EVALUATION OF THE MICHIGAN MATERNAL INFANT HEALTH PROGRAM

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INTRODUCTION

In 2011 the Michigan Department of Health and Human Services requested that Michigan State University propose a research plan for an evidence-based evaluation of MIHP effectiveness in promoting healthy pregnancies, positive birth outcomes, and healthy infants. A randomized trial was not feasible as Medicaid is an entitlement program and all insured pregnant women were eligible for MIHP. As a result, the Michigan State University research team proposed a quasi-experimental evaluation of the program. Unlike other home visiting program evaluations, some focusing on very small, selected samples, this evaluation is representative for the entire MIHP program and for the Michigan population of Medicaid-eligible pregnant women and infants. This year new methods complemented the continuing quasi-experimental analyses in order to expand the understanding of MIHP's effectiveness in improving population health care and outcomes in Michigan. In addition, new health outcomes were explored this year, as well as demographic and geographic variations in program effectiveness.

To date, the program of research has helped MIHP meet United States Department of Health and Human Services (HHS) criteria for an evidence-based program through publications in peer-reviewed journals and presentations to research, policy, and public health audiences. Specifically, 3 papers were accepted for publication in high-impact research journals (Meghea et al, 2013; Roman et al, 2014; Meghea et al, 2015). An additional manuscript is under consideration for publication in peer-reviewed research journals, and 4 manuscripts are under preparation and will be submitted for publication. In addition, the findings were presented to physicians, policy makers, and community members, and at state, national and international research and policy conferences.

This year, a variety of methods were used to continue the research program evaluating the effectiveness of MIHP. A quasi-experimental design continued to be used, complemented by

propensity score adjusted multivariate analyses and descriptive explorations, and analyzed four linked successive birth cohorts allowing for the exploration of new health outcomes.

The matched comparison group (MCG) method was used as the quasi-experimental evaluation strategy. This proposed evaluation design aimed to establish baseline equivalence on selected measures. The aim of MCG was to create a comparison group so that each case in the intervention group (MIHP participants) is matched with an equivalent comparison case. This eliminates observable differences between the two groups that might lead to inaccurate estimates of the intervention's effect. Unlike some of the existing matched comparison group studies that match comparison cases based on one or few characteristics, propensity score matching was used to compare MIHP participants to non-MIHP participants. Propensity score matching methods match each individual in the MIHP intervention group to equivalent nonparticipants based on several characteristics.

New this year, analyses were performed to account for MIHP participant-nonparticipant differences on a significantly expanded set of risk factors. The purpose was to address the main limitation of the propensity score matched analyses, namely the possibility of bias due to unobserved characteristics. Among women with prenatal MIHP screening, those screened-only (quasi nonparticipants) were compared to those who were screened and received additional MIHP services. To evaluate the effects of receiving MIHP services, propensity score adjusted regression analyses were used to account for differences measured in an extensive set of prenatal screened risk factors. Also new this year, previously unexplored outcomes were analyzed (e.g. depression diagnostic, treatment, follow-up and continued care; closely spaced subsequent pregnancy and birth), other outcomes were investigated in more detail (e.g. infant death by race, time of death, and cause of death), and demographic and geographic variations in MIHP effectiveness were explored (e.g. replicated analyses in Detroit's Wayne county, in the Detroit tri-county area, and in the Upper Peninsula counties).

This report presents updated key findings from a population-based rigorous multi-method evaluation of MIHP effects on maternal and infant health and health services utilization during pregnancy, at birth, and during the infant's first year of life. New methods complemented the quasi-experimental matching strategy to investigate the pattern of MIHP effectiveness in four successive statewide birth cohorts, in subpopulations with different geographical and demographic characteristics, and to explore selected results in further detail.

THE MATERNAL INFANT HEALTH PROGRAM (MIHP)

The Maternal Infant Health Program (MIHP), a population-based home visiting program targeting all Medicaid-eligible pregnant women and infants up to age one, has received significant attention and effort over the recent years. The MIHP, which is jointly administered by Medical Services Administration and the Bureau of Maternal and Child Health, Michigan Department of Health and Human Services (MDHHS), is the largest program dedicated to serving Medicaid pregnant women and children in the state. MIHP provides support to promote healthy pregnancies, positive birth outcomes, and healthy infants.

The MIHP is administered by a network of certified provider agencies throughout the state in rural, urban, and native communities. Providers are located in private freestanding offices, hospital-based clinics, federally qualified health centers, and in local/regional public health departments. MIHP services include:

- evidence-based maternal and infant health and psychosocial assessments completed by registered nurses or social workers;
- comprehensive, individualized plans of care developed by teams comprised of RNs, licensed social workers, and infant mental health specialists;
- coordination of services between MIHP providers, medical care providers and Medicaid health plans; and
- interventions based on the participant's plan of care, which may include but are not limited to referrals for community services (e.g., mental health, substance abuse, domestic violence, basic needs assistance, referral to local childbirth education or parenting classes).

The Michigan Department of Health and Human Services continually assesses and improves MIHP to meet the needs of Michigan residents while demonstrating value in the challenging economic environment.

DATA and METHOD

Design

The evaluation research program was designed according to the United States Department of Health and Human Services (HHS) criteria for an “evidence-based early childhood home visiting service delivery model”. The study had a *quasi-experimental design and created matched*

comparison groups with baseline equivalence on a variety of characteristics. This eliminated observed differences that might lead to inaccurate estimates of the intervention's effects. Subjects enrolled in MIHP were matched to nonparticipants based on similar characteristics. Matched comparison groups were selected using propensity scores, the estimated probability of MIHP assignment conditional on the observed baseline characteristics.

In addition, MIHPs effectiveness was tested in various subpopulations, with differences both geographically and in terms of racial composition, potential access to MIHPs services, and other demographic characteristics. Subpopulation matched analyses were performed in Detroit's Wayne County population, the Detroit tri-county area population, and the Upper Peninsula Michigan counties. Evaluating the effectiveness in these subpopulations was relevant to assess the MIHP's evidence-based status as a population management model, available to all Medicaid pregnant women and infants, with services available in all Michigan counties.

A potential limitation of the propensity score matched analyses comparing MIHP participants to nonparticipants is the possibility of bias due to unobserved differences as a result of a relatively small number of individual matching characteristics observed for all pregnant women and their infants in Michigan. To mitigate this potential problem, additional analyses were performed in 2013-2014 using an alternative methodology. Specifically, within the statewide subpopulation of women with a prenatal MIHP screening, those screened-only (quasi nonparticipants) were compared to those who were screened and received additional service. To evaluate the effects of receiving MIHP services, *propensity score adjusted regression analyses* were used to account for differences measured in an extensive set of screened risk factors, in addition to the characteristics used in the propensity score matching process in the full Medicaid pregnant population.

Study populations

All singleton births in Michigan between 1/1/2009 – 12/31/2012 (N=248,059) with both mother and infant covered by Medicaid in calendar years were included in this study. Infant–mother linked pairs were constructed using an MDHHS proprietary algorithm linking Medicaid beneficiaries with a Master Record Number. Mothers were followed from 6 months before conception, through pregnancy, at birth, and for the first 12 months postpartum (for those who maintained continuous Medicaid eligibility). The infants were followed up from birth through the first 12 months of their lives.

Data sources

Data were assembled from the MDHHS data warehouse. All Medicaid maternal medical claims, monthly Medicaid eligibility beginning 6 months prior to conception, during pregnancy, and through the first 12 months postpartum (for those who retained Medicaid eligibility), and other program participation (such as cash assistance) were linked to infant birth records, infant death records, monthly infant Medicaid eligibility, and infant medical claims for the first 12 months of life. Data were assembled for all births between 1/1/2009 and 12/31/2012.

RESULTS

Overall MIHP participation and maternal health, matched analyses

Women who enrolled in the MIHP had better prenatal and postnatal care compared to matched women who did not participate in the program:

- MIHP participants were more likely to receive prenatal care; the results were replicated in CY2009, CY2010, CY2011, and CY2012 birth cohorts. MIHP reduced the rate of women receiving no prenatal care by over two thirds compared to women not participating in MIHP (over 99% of MIHP women received prenatal care).
- MIHP participants were more likely to receive adequate prenatal care compared to matched women not participating in MIHP; the results were replicated in both CY2009 and CY2010 birth cohorts
- MIHP participation increased the rate of women receiving appropriately-timed postnatal checkups by close to one fourth; results were replicated in CY2009, CY2010, CY2011, and CY2012 birth cohorts
- MIHP participation increased the enrollment of eligible women in the Plan First! family planning program after birth among CY2011 women; the result were replicated in CY2012 among women who enrolled early and received a dosage of MIHP services.

Overall MIHP participation and infant health, matched analyses

Infants participating in MIHP had a higher use of preventive health services compared to matched infants not participating in the program:

- MIHP had a strong favorable effect in increasing the likelihood of infants receiving any well-child visits over the first year of life by in CY2009, CY2010, CY2011, and CY2012: the risk of receiving no visits was reduced by as much as half in 2011, to less than 4%

- MIHP had a strong favorable effect in increasing the likelihood of infants receiving the appropriate number of well-child visits over the first year of life by approximately 7% in CY2009, CY2010, CY2011, and CY2012.

Overall MIHP participation and infant mortality, matched analyses

In order to get adequate sample size and the ability to analyze infant mortality by race and time of death, the four birth cohorts CY2009-CY2012 were aggregated in the analyses.

- MIHP participation reduced the risk of infant mortality, close to half compared to a matched comparison group of nonparticipants. Infant mortality risk was reduced, both among Black infants and among infants of other races. When exploring neonatal and post-neonatal mortality, the MIHP effects were consistent in reducing neonatal mortality, and less so affecting post-neonatal mortality. The analyses suggest that infant mortality risks may have been reduced as a result of MIHP improving prenatal care and birth outcomes, consistent with neonatal program effects. Further supporting these findings, cause of death qualitative analyses revealed that MIHP participants had fewer infant deaths related to gestation length and fetal growth and to complications of pregnancy, labor, and delivery than matched nonparticipants, and both groups had similar SIDS rates. Unlike the effects in reducing the risk in adverse birth outcomes, where MIHP did show particular advantage for Black women, suggesting potential reductions in birth outcomes racial disparities, the results of this study did not indicate MIHP effects in reducing the racial disparities in infant mortality.

MIHP effectiveness among participants enrolled in the first two pregnancy trimesters and with more than three prenatal MIHP contacts, matched analyses

In general, the overall positive MIHP impacts reported above were more pronounced among the participants who enrolled in the first two pregnancy trimesters and had at least three pregnancy MIHP contacts in addition to risk-screening. Selected results are included below.

- MIHP participation increased the rate of women receiving appropriately-timed postnatal checkups by over one fourth in CY2009, CY2010, CY2011, and CY2012
- MIHP reduced by up to two thirds the risk of very low birth weight in CY2009, CY2010, CY2011, and CY2012
- MIHP reduced by up to one fifth the risk of low birth weight in CY2009, CY2010, CY2011, and CY2012

- MIHP reduced by up to a third the risk of very preterm births in CY2009, CY2010, CY2011, and CY2012
- MIHP reduced the prematurity risk by up to a quarter in CY2009, CY2010, CY2011, and CY2012
- MIHP participation reduced the risk of receiving no well-child visits in the first year of life by over a half, to less than 3% in CY2009, CY2010, CY2011, and CY2012
- MIHP participants had lower infant mortality, close to half compared to a matched comparison group of nonparticipants. Infant mortality risk was reduced, both among Black infants and among infants of other races.

MIHP effectiveness confirmed in matched analyses in three very different subpopulations

The MIHP favorable effects on maternal and infant health care use and health outcomes, during pregnancy, at birth, and first year after birth were confirmed in three very different subpopulations. Specifically, in Detroit's Wayne County population, MIHP participation improved prenatal and postnatal care, increased weight and gestational age at birth, reduced risk of prematurity, extreme prematurity, LBW and VLBW, increased odds of receiving any well-child visits, and the appropriate number of well-child visits in the 1st year of life, and reduced the risk of infant mortality. In the Detroit tri-county area, MIHP participation improved prenatal and postnatal care, increased weight and gestational age at birth, reduced risk of prematurity, extreme prematurity, LBW and VLBW, increased odds of receiving any well-child visits, and the appropriate number of well-child visits in the 1st year of life, and reduced the risk of infant mortality. In the Upper Peninsula counties, MIHP participation improved prenatal and postnatal care, increased gestational age at birth, reduced risk of prematurity, increased odds of receiving any well-child visits, and the appropriate number of well-child visits in the 1st year of life.

MIHP effectiveness among women with prenatal MIHP risk screening: screened-only (quasi nonparticipants) vs. screened plus services

The favorable MIHP effects on maternal and child health care and outcomes were confirmed when comparing women screened-only (quasi nonparticipants) to women who were screened and received additional prenatal MIHP services. The comparison used regression analyses to account for an extensive set of differences in prenatal screened risk factors (e.g. prior pregnancy complications, whether the pregnancy was planned, obesity, drug use, stress, depressive symptoms, history of mental health issues, history of abuse, and unaddressed basic needs), in

addition to the characteristics used in the propensity score matching process in the full Medicaid pregnant population. Those screened into MIHP during pregnancy who received additional MIHP services, compared to those screened-only with no additional MIHP services, had:

- Twice the odds of receiving prenatal care
- Increased odds of receiving adequate prenatal care by 13%
- Increased odds of women receiving appropriately-timed postnatal checkups by over one fourth
- Increased odds of women enrolling in the Plan First! family planning program after birth by one fifth
- Increased birth weight and gestational age at birth, while statistically significant, the effects were not clinically meaningful
- Reduced odds of LBW by close to a fifth
- Reduced odds of VLBW by close to 40%
- Reduced odds of prematurity by close to a fifth
- Reduced odds of extreme prematurity by one third
- Increased odds of infants receiving any well-child visits over the first year of life by 45%
- Increased odds of infants receiving any well-child visits over the first year of life by close to a third

MIHP and infant safety

MIHP did not reduce the rates and counts of infant injury related visits in the first year of life. The findings were confirmed in matched analyses, racial and geographical subpopulation analyses, and in comparisons of those screened and receiving additional MIHP services to those screened-only. Comparing all MIHP participants and those enrolled early and who received a dosage of MIHP services to matched controls within specific injury categories, and accounting for diagnoses and the severity of the injury/poisoning episodes, most of the difference was explained by higher odds and counts of superficial injury episodes among MIHP participants. A positive finding was that MIHP infants seemed to have fewer poisoning-related visits. Possible explanations for the higher rates and counts of injury related visits among MIHP participants may include increased health-seeking behavior of the mothers, consistent with other MIHP effects on maternal health care use, or improved recognition of infant injuries that warrant medical attention.

DISCUSSION

Overview of key maternal and infant improvements for MIHP participants

Characteristic	Description of improvement(s)
Maternal and infant care	<p>MIHP participation increased the odds of receiving prenatal care improved the adequacy of prenatal care through pregnancy.</p> <p>MIHP participation increased the odds of an appropriate postnatal visit,</p> <p>MIHP participation increased the odds of enrollment in the Plan First! family planning program after birth for those who lost Medicaid eligibility</p> <p>MIHP had a strong favorable effect in increasing the likelihood of infants receiving any well-child visits over the first year of life.</p> <p>MIHP had a strong favorable effect in increasing the likelihood of infants receiving the appropriate number of well-child visits over the first year of life</p> <p>The MIHP effects were more pronounced among participants who enrolled in MIHP in the first two pregnancy trimesters and received three or more prenatal MIHP contacts.</p>
Maternal and infant health outcomes	<p>MIHP early enrollment and a dosage of services reduced the risk of prematurity, extreme prematurity, low birth weight, and very low birth weight.</p> <p>MIHP participation reduced the risk of infant mortality, possibly through improvements in prenatal care and birth outcomes. Infant mortality risk was reduced, both among Black infants and among infants of other races.</p> <p>Similar to other programs, more infant injuries were found among MIHP participants, mostly explained by more superficial injuries. A positive finding was that MIHP infants seemed to have fewer poisoning episodes, a more severe occurrence.</p>

Positive MIHP effects were sustained in four successive statewide birth cohorts. There continued to be a pattern of significant favorable effects across a range of maternal and infant care and health outcomes during pregnancy, at birth, and through the first year after birth. Quasi-experimental matched analyses revealed that MIHP improved prenatal care, increased the odds of an appropriate postnatal visit, increased the odds of enrollment in the Plan First! family planning program among women who lose Medicaid eligibility after birth, reduced the risk of prematurity, extreme prematurity, low birth weight, and very low birth weight, improved the infant use of preventive health services, and reduced risk of infant mortality likely through improvements in prenatal care and reductions in adverse birth outcomes. The effects were broader and more pronounced among participants who enrolled early during pregnancy and received more than three additional prenatal MIHP contacts.

Multiple birth cohort analyses revealed new information regarding the MIHP favorable effects in reducing the risk of infant mortality. Infant mortality risk was reduced, both among Black infants and among infants of other races. The reductions were consistent in neonatal infant mortality, and less so in post-neonatal infant mortality. The analyses suggest that infant mortality risks may have been reduced as a result of MIHP improving prenatal care and birth outcomes, in line with the consistent neonatal program effects. Further supporting these assertions, cause of death qualitative analyses revealed that MIHP participants had fewer infant deaths related to gestation length and fetal growth and to complications of pregnancy, labor, and delivery than matched nonparticipants, and both groups had similar SIDS rates. Unlike the effects in reducing the risk in adverse birth outcomes, where MIHP did show particular advantage for Black women, suggesting potential reductions in birth outcomes racial disparities, the results of this study did not indicate MIHP effects in reducing the racial disparities in infant mortality. The quasi-experimental matched analyses also confirmed the statewide MIHP wide range of MIHP favorable effects in three different subpopulations: Detroit's Wayne County, the Detroit tri-county area, and Michigan's Upper Peninsula.

A potential limitation of the matched analyses comparing MIHP participants to nonparticipants is the possibility of bias due to unobserved differences as a result of a relatively small number of individual matching characteristics observed for all pregnant women and their infants in Michigan. To mitigate this potential problem, additional analyses were performed in 2013-2014 using an alternative methodology. Specifically, within the statewide subpopulation of women with a prenatal MIHP screening, those screened-only (quasi nonparticipants) were compared to those who were screened and received additional service. To evaluate the effects of receiving MIHP services, propensity score adjusted regression analyses were used to account for differences measured in an extensive set of screened risk factors, in addition to the characteristics used in the propensity score matching process in the full Medicaid pregnant population. The favorable MIHP effects found in the matched comparisons were confirmed in analyses that accounted for a comprehensive set of screened risk factors that were different between program participants and nonparticipants at enrollment.

In addition, the effects of MIHP on previously unexplored outcomes were investigated. Preliminary propensity score matched analyses indicated that MIHP participants were more likely to receive a depression diagnosis or have an initial depression treatment claim, have at

least 1 follow up visit, and get continued depression care with at least three additional visits during a 120 day period when compared to women not in MIHP. Preliminary analyses on the effects of MIHP participation on rapid repeat pregnancy and birth were not conclusive. Additional analyses will be performed to increase the understanding of the findings.

MIHP meets the DHHS federal criteria for an evidence-based program through publications in peer-reviewed journals and presentations to various audiences. Specifically, 3 manuscripts were accepted for publication in high-impact research journals. An additional manuscript is under consideration for publication in peer-reviewed research journals, and four more are under preparation to be submitted for publication in a peer-reviewed research journal. In addition, the findings were presented to physicians, policy makers, public health audiences, and community members, and at state, national and international research and policy conferences.

MIHP participation improved maternal and infant *health care utilization*, with effects sustained in the statewide 2009, 2010, 2011, and 2012 birth cohorts and generally robust to the possibility of unobserved bias. These findings were consistent with the role of the MIHP case manager to coordinate care with the participant's medical care provider and Medicaid Health Plan and remove barriers to participation in care. Most of the effects were more pronounced for women who enrolled in MIHP in the first two pregnancy trimesters and received a dosage of more than three prenatal MIHP contacts, consistent with prior research that found stronger program effects among participants enrolling early and receiving a dosage of services.

Prior randomized controlled trials (RCT) of other home-visitation programs did not find positive effects on the use of prenatal care. To our knowledge, there are no prior RCT or quasi-experimental evaluations of the effects of home-visitation programs on the receipt of appropriate postnatal care or on enrollment in family planning programs.

The findings of improved infant use of preventive services were in line with RCT evaluations of other home-visitation programs and consistent with prior findings of improvements in maternal health care utilization and the role of MIHP case manager. RCT evaluations of the Healthy Steps home visiting program, which targets children from birth to age 3, found that participating infants were more likely to have the one-month and the 24-month well-child visits (Guyer et al., 2003; Johnston et al., 2004). The Healthy Families San Diego program, which focuses on pregnant women and their children, increased the number of well-child visits at the 3rd year follow-up (Landsverk et al., 2002).

MIHP improved maternal and infant *health outcomes*. Notably, the MIHP effects improving birth outcomes were broader and more pronounced among participants who enrolled in MIHP in the first two pregnancy trimesters and received a dosage of more than three prenatal MIHP contacts (Roman et al, 2013). The results are consistent with several RCT 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 (Lee et al, 2009; Norbeck et al, 1996). These studies found no program effect on reducing prematurity. Another study 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 low birth weight and prematurity, but relied on a small sample size (N=84 in the intervention group), limited matching characteristics, and did not account for timing and dosage of services (Cooper et al, 2012). A recent study using propensity score adjusted regression analyses found that receiving a moderate amount of prenatal care management services decreased the odds of having a LBW or PTB in non-Hispanic white women in Iowa (Slaughter et al, 2012).

A major advantage of using multiple statewide cohorts is the very large sample size of the analyzed population. The large sample size allows the identification of program effects on rare outcomes (such as infant mortality), that may otherwise be unidentifiable in smaller groups such as randomized controlled trials. The combination of large, multi-year, linked population-based birth cohorts, quasi-experimental methods, and subgroup analyses is unique when assessing effects of home visitation on infant mortality. The findings that MIHP participation reduced infant mortality risk are consistent with a statewide home visiting study in Oklahoma that reported lower infant mortality prevalence among program participants compared to nonparticipants (Carabine, 2005). However, the results were limited to firstborn infants of single mothers without pregnancy risk factors (e.g. prior stillbirth) and the authors did not select a matching comparison group to account for potential bias. A study of a community-based home visitation program, Cincinnati's Every Child Succeeds program, also demonstrated reduced risk of infant death, with program nonparticipants 2.5 times more likely to die in infancy than home visiting participants (Donovan, 2007). The study matched some of the program participants to nonparticipants, but the matching relied on a limited set of characteristics. Neither of the two studies accounted for the timing and dosage of services.

To conclude, positive MIHP effects were sustained in four successive statewide birth cohorts. There was a continued pattern of significant favorable effects across a range of maternal and infant care and health outcomes during pregnancy, at birth, and through the first year after birth. The effects were broader and more pronounced among participants who enrolled early during pregnancy and received a dosage of prenatal MIHP services. The quasi-experimental matched analyses confirmed the statewide MIHP wide range of MIHP favorable effects in three different subpopulations: Detroit's Wayne County, the Detroit tri-county area, and Michigan's Upper Peninsula. The favorable MIHP effects were sustained in analyses that accounted for an expanded set of screened risk factors that were different between those who received additional MIHP services and those screened-only. Through a multi-method approach, the findings further support the evidence-based effectiveness of MIHP as a population management home visiting program. The MIHP quasi-experimental evaluation research program continues and will include the most up to date birth cohorts, exploration of MIHP effects in new domains, and program fidelity and cost-benefit analyses.

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