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WIC-Medicaid II Feasibility Study: Final Report Appendices

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WIC–Medicaid II Feasibility Study: Final Report Appendices

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APPENDICES

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APPENDIX A

OVERVIEW OF RECENT LITERATURE ON THE EFFECTS OF THE SPECIAL SUPPLEMENTAL NUTRITION PROGRAM FOR WOMEN, INFANTS, AND CHILDREN

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The existing body of research on the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) program is large in size and scope. With respect to impacts on birth-, nutrition- and health-related outcomes, WIC is the most widely studied of the 15 nutrition assistance programs administered by the Food and Nutrition Service. The WIC-Medicaid II Feasibility Study (WM-II) included a comprehensive review of all research on WIC program impacts published from 2002 to 2010 as well as gray or unpublished research completed from 1999 to 2010.[1] Findings from this review were published in a separate report (Colman et al. 2012). The WM-II literature review updates an earlier literature review completed by Fox et al. (2004). This appendix summarizes the key findings of that report. Readers are encouraged to refer to the full report for important details about the approaches researchers used to deal with selection bias, other methodological challenges that affect conclusions, and a discussion of the strengths and weaknesses of the individual studies. In addition, it is important to recognize that all research included in the review was conducted before comprehensive revisions to the WIC food packages, which were implemented in 2009.

1. Impacts on pregnancy and birth outcomes

The literature search identified 15 studies that evaluated the association between WIC participation and birth- and pregnancy-related outcomes. The most commonly evaluated birth outcomes in the identified studies were measures of birthweight (such as mean birthweight, the rate of low [fewer than 2,500 g] or very low [fewer than 1,500 g] birthweight); measures of gestational age, such as length of gestation in weeks or rate of preterm (fewer than 37 weeks) delivery; and measures of fetal growth restriction (such as small for gestational age (SGA) or term low birthweight). Less common outcomes include the incidence of fetal death and whether the infant was placed in neonatal intensive care after delivery. Fourteen studies evaluated one or more of these birth outcomes. Three studies evaluated pregnancy-related mediating factors such as the mother's weight gain during pregnancy or modifiable risk behaviors, such as smoking during pregnancy.

The reviewed studies found a positive association between prenatal WIC participation and gestational age and mean birthweight and a negative association with the incidence of low and very low birthweight when the estimates were not adjusted for gestational-age bias. Estimates for mean birthweight unadjusted for gestational age were typically moderate. Estimates for the incidence of low and very low birthweight unadjusted for gestational age generally suggested substantial improvements associated with WIC. For example, Bitler and Currie (2005) found a nearly 30 percent reduction in the rate of low birthweight and a 54 percent reduction in the rate of very low birthweight. Given that most low-birthweight infants are born prematurely, the estimates for measures of gestational age, such as the incidence of preterm delivery, were generally in line with the estimates of the rate of low and very low birthweight. In contrast, evidence of the association between prenatal WIC participation and measures of fetal growth was less consistent. Generally, the magnitude of the impacts was substantially smaller than the estimates for unadjusted measures of birthweight. A few studies found a weak or no association

[1] This body of research includes all studies not reviewed in a previous comprehensive review of the literature (Fox et al. 2004).

(Joyce et al. 2005; Foster et al. 2010; Rivera 2008), and a few found sizable effects (Bitler and Currie 2005; Figlio et al. 2009).

Evidence of the association between prenatal WIC participation and mediating factors such as weight gain during pregnancy and smoking were limited. Two studies suggested that WIC might reduce the likelihood of smoking during pregnancy (Brodsky et al. 2009; Yunzal et al. 2010). However, as Yunzal et al. (2010) noted, some evidence suggested that women who enrolled in WIC were also more likely to quit smoking before enrollment. Therefore, the association between smoking cessation and WIC could be spurious and should be interpreted with caution. The findings from Brodsky et al. (2009) were mixed, with no clear evidence of a positive WIC effect. Recent research provides no clear evidence of an association between WIC and adequate weight gain during pregnancy. Findings from the only study that evaluated the average weight gain among underweight women found mixed results: a positive association with first-trimester enrollment in WIC and a negative association with third-trimester enrollment.

2. Impacts on infant feeding practices

The literature search identified 13 studies that evaluated the association between WIC participation and infant feeding practices. Five studies focused on prenatal participation, and 8 evaluated the impacts of postpartum, child, or any WIC participation. The most common outcome measures of infant feeding practices included initiation and duration of breastfeeding, exclusive breastfeeding, and introduction of infant formula. Less frequently, authors evaluated the timing of the introduction of cow's milk or solid foods.

Overall, the reviewed research suggested lower rates of breastfeeding among WIC participants compared with nonparticipants. However, it cannot be determined whether this pattern was due to WIC or to underlying differences between WIC participants and nonparticipants. One study found a positive association between prenatal WIC participation and initiation of breastfeeding (Park et al. 2003). Another study found that women who enrolled in WIC postpartum were more likely than women who enrolled prenatally to initiate breastfeeding (Chatterji and Brooks-Gunn 2004). However, the study found no difference between the two groups in terms of breastfeeding duration. Some evidence suggested that providing infant formula through WIC delayed the introduction of cow's milk in infants' diets (Jacknowitz et al. 2007; Ziol-Guest and Hernandez 2010).

3. Impacts on infant and child dietary intake, food security, and related outcomes

The literature search identified 16 studies that estimated the effects of WIC participation on the dietary intake of infants and/or children, household food security, summary measures of diet quality, knowledge about infant feeding practices, and food labeling behaviors.

Overall, the reviewed research suggested that WIC participation was associated with improved diets. One study found that WIC participation increased the iron density of preschoolers' diets, increased consumption of fruits and vegetables, and reduced the intake of fats (Siega-Riz et al. 2004); three studies found that WIC participants consumed fewer added sugars than nonparticipants (Bhargava and Amailchuk 2007; Kranz and Siega-Riz 2002; Siega-Riz et al. 2004); two studies found that WIC participation increased the variety of foods

consumed (Knol et al. 2004; Ver Ploeg 2009); and one study found that zinc intake of children was positively related to WIC participation (Arsenault and Brown 2003). Evidence was inconsistent on the association between WIC participation and energy intake (Mendoza et al. 2006; Oliveira and Chandran 2005). Two studies found no significant relationship between WIC participation and calcium intakes (Siega-Riz et al. 2004; Ishdorj et al. 2007), but one study found a positive relationship between WIC participation and calcium available from household food supplies (Bhargava and Amialchuk 2007). One study evaluated the consumption of WIC-approved foods and found that children on WIC had higher energy intake from WIC-approved foods relative to both income-eligible and -ineligible nonparticipants (Oliveira and Chandran 2005).

Two studies evaluated food security status and neither found a significant relationship between WIC participation and household food security when examined in a multivariate framework (Black et al. 2004; Oberholser and Tuttle 2004). Two studies reported a negative association between WIC participation and nutrition-related knowledge and behaviors (Ollberding 2009; Wojcicki et al. 2009). However, neither of these studies controlled adequately for other factors that influenced these outcomes.

4. Impacts on infant and child growth outcomes

The literature search identified seven studies that examined the relationship between WIC participation and infant and child growth. The most commonly evaluated outcomes were the likelihood of being overweight or at risk of overweight. Other outcomes included the likelihood of being underweight and being diagnosed as failure to thrive.

Overall, the evidence on the association between WIC participation and infant and child growth outcomes was mixed. Findings from the only study that evaluated growth outcomes among infants suggested that, compared with WIC participants, infants who did not participate in WIC because their caregivers perceived problems with program access tended to be shorter and to weigh less (Black et al. 2004). Among the six studies that evaluated overweight status among children older than 12 months (up to age 6 in some cases), two suggested a significant reduction in the risk of being overweight among WIC participants relative to nonparticipants (Melgar-Quiñonez and Kaiser 2004; Bitler and Currie 2004); one suggested that WIC was associated with a greater likelihood of being overweight among white children but not among blacks or Hispanics (Rose et al. 2006); and three showed either no significant relationship or no consistent evidence of either a positive or a negative relationship (Black et al. 2004, Ver Ploeg et al. 2008; Rivera 2008). A study evaluating the incidence of failure to thrive by age 5 found a lower rate among both WIC participants and joint WIC and Food Stamp Program participants compared with children not enrolled in either program (Lee and Mackey-Bilaver 2006).

5. Impacts on child immunization

The literature search identified three studies that evaluated the association between children's WIC participation and their immunization status. Outcomes analyzed in the three studies include the up-to-date immunization status among children ages 19 to 35 months, as defined by the recommended childhood immunization schedule, and rates of hepatitis A vaccination by age 2 years.

Findings from the available research were inconclusive. Santoli et al. (2004) found no significant association between children's WIC participation and their up-to-date status for routine vaccinations. Luman et al. (2003) found that children with current WIC participation were more likely to be up to date on their routine vaccinations than children who (1) were eligible for WIC but never participated, (2) participated in the past but were not currently participating, or (3) were ineligible for WIC. A problem with both of these studies is that they used a measure of WIC participation that could not assert whether enrollment in WIC preceded vaccination. Weston and Enger (2010) used a more appropriate measure of WIC participation but did not provide a straightforward interpretation of the association between WIC participation and hepatitis A vaccination. Their estimates, adjusted for a limited number of demographic characteristics, suggested that, compared with children who received neither Medicaid nor WIC at age 1, those who received both Medicaid and WIC had a higher vaccination rate, but those who received WIC only did not differ in this outcome. Given that the comparison group likely included children from households with higher incomes who did not qualify for either WIC or Medicaid, the lack of difference in hepatitis A vaccination between this group and children who participated in only WIC might be encouraging.

6. Impacts on infant and child use of health care services and related costs

The literature search identified six studies that evaluated the association between WIC participation and use of health care services among infants or children and associated Medicaid costs. Three studies evaluated the association between WIC participation and the use of preventive care, such as receipt of well-child visits or Early Periodic Screening and Diagnosis and Treatment Program (EPSDT) services. One study evaluated the association between WIC participation and the likelihood of being diagnosed with common childhood illnesses. Two studies focus on use of dental care, both preventive and restorative. Finally, two studies evaluated the association between child WIC participation and Medicaid expenditures.

Overall, the reviewed studies suggested that children who participated in WIC or whose mothers were on WIC used more preventive and curative health care services than nonparticipants. Findings from Buescher et al. (2003), the most widely cited study in this literature, suggested that children on Medicaid who were also on WIC were more likely to receive EPSDT services and well-child visits, to be hospitalized, to use the emergency room, and to be diagnosed with common childhood illnesses. As a result, Medicaid costs associated with health care use were also higher among WIC participants. Other studies reported similar findings for receipt of well-child visits, EPSDT visits, and the use of dental care services (Chatterji and Brooks-Gunn 2004; Lee and Mackey-Bilaver 2006; and Lee et al. 2004a, 2004b). Buescher et al. (2003) suggested that these findings indicated WIC participants were better connected to the health care system and thus more likely to be diagnosed and treated for childhood illnesses. However, an alternative explanation—that children who were more connected to the health care system in general were also more likely to enroll in WIC—cannot be ruled out.

7. Impacts on child health and socioemotional and cognitive development

The literature search identified eight studies that analyzed the association between WIC participation and various measures of child health and development. Two studies evaluated the prevalence of childhood morbidity as measured by diagnosis of illnesses such as asthma, a respiratory illness, a severe gastrointestinal illness, ear infection, or other common childhood

illnesses. Four studies evaluated a general health rating of the child, based on either a caregiver's report or a physician's assessment, and one study evaluated children's cognitive, motor, and socioemotional abilities.

The limited available research provides no clear evidence of either a positive or negative association between WIC participation and child health and development. Carlson and Senauer (2003) found a positive relationship between WIC participation and physicians' assessments of children's health among a sample of WIC-eligible children, as well as based on a larger sample that included children from more-advantaged families. Among infants 12 months or younger, Black et al. (2004) found that, compared with children in families who did not participate in WIC because of perceived access problems, children receiving WIC benefits were less likely to be in fair or poor health, as reported by the caregiver. Rivera (2008) found a marginally significant negative association between WIC participation and mother's report of child's health status at age 24 months for a subgroup of children (as defined by their estimated propensity to participate in WIC), but no significant impacts for health at 9 months. Findings from Sparks (2010) suggest no association between WIC participation and ratings of children's general health or physician's diagnosis of illnesses as reported by the mother.

Buescher et al. (2003) found a higher incidence of diagnosis of common childhood illnesses among WIC participants compared with nonparticipants, which they attributed to the greater use of health care services among WIC participants. Estimates from Rivera (2008) suggested no consistent association between prenatal WIC participation and children's cognitive, motor, and socioemotional abilities. Two studies examined the prevalence of iron deficiency or iron deficiency anemia and found that WIC participation was associated with reduced prevalence of iron deficiency and iron deficiency anemia (Schneider et al. 2008; Park et al. 2009). Two other studies examined the relationship between WIC participation and the likelihood of being diagnosed with anemia and other measures of nutritional deficiency. One study found that child WIC participation was associated with an increased prevalence of being diagnosed with anemia and all measures of nutritional deficiency (Buescher et al. 2003), whereas the other found the exact opposite (Lee and Mackey-Bilaver 2006).

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APPENDIX B

DATA SOURCES AND DATA LINKAGE

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To study the associations among Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) participation, birth outcomes, health care use, and Medicaid costs, we linked data from three different Oklahoma and Missouri agencies—WIC, Medicaid, and Vital Records. The process of linking administrative data files was analytically and technically challenging, as well as resource intensive. This appendix provides a detailed description of the process used to create the final linked database, including a description of the files, how we prepared the data files, the methods and variables used for linking, and an assessment of the quality of the data linkage.

A. Data overview

The WIC-Medicaid II Feasibility Study (WM-II) required several types of administrative records: (1) WIC certification records; (2) WIC food voucher issuance and redemption records; (3) Medicaid eligibility records; (4) Medicaid claims; and (5) birth, fetal death, and death certificates from Vital Records agencies. Each of these files contained variables used for the sole purpose of linking records for the same individual across files. In addition, the Vital Records data (particularly the birth certificates) and the Medicaid claims provided variables used to construct outcome measures or control variables used in the analysis. For example, the Vital Records files provided information on the prevalence of low birthweight infants, neonatal mortality rates, breastfeeding initiation, and maternal weight gain. The Medicaid claims were used to construct measures of health care use and Medicaid costs. WIC records provided information about WIC enrollment and use of WIC benefits that identified WIC participants. The birth certificates and Medicaid eligibility records also provided data on sociodemographic characteristics used to control for differences between WIC participants and nonparticipants in estimating associations between WIC participation and the outcomes of interest.

Table B.1 lists the data elements included in each of the key data files for the WM-II prenatal analysis. Table B.2 shows similar information for the WM-II children's analysis.

Table B.1. Data sources and data elements for the prenatal analysis

Data source	Purpose	Data elements: For record selection and file linkage	Data elements: For analysis
Medicaid			
All claims for women with labor and delivery claims	Identify sample and measure costs and utilization From birth through 60 days postpartum (WM-I measure) and from prenatal period through 60 days postpartum (WM-II measure)	Medicaid number Name SSN Race Address County Provider Service dates	Service dates Claim type Provider type Provider code Diagnosis codes Procedure codes DRG codes Amount paid by Medicaid
Enrollment records: women of childbearing age	Obtain demographic information	Medicaid number Name SSN Race Address County Provider Certification date Eligibility category	Household size Household income Participation in SNAP and/or TANF[a]
Claims for newborn care with service date within 60 days of birth	Identify sample and measure costs	Medicaid number Name SSN Race Sex Birth date Address County Service dates	Service dates Claim type Provider type Provider code Diagnosis codes Procedures codes DRG codes Amount billed Amount paid by Medicaid Amount third-party liable
Enrollment records: newborns	Obtain demographic information	Medicaid number Name SSN Race Address County Provider Certification date Eligibility category	Family size Family income Participation in SNAP and/or TANF[a]

Data source	Purpose	Data elements: For record selection and file linkage	Data elements: For analysis
WIC			
Certification records, pregnant women	Identify WIC participants	Certification date Family ID[c] Participant ID[d] Name SSN Certification category Address County Pregnancy outcome Actual delivery date	Minimum Data Set[b] Supplemental Data Set[b] First WIC certification date Number in household on WIC Termination date Termination reason code
Certification records, infants	Obtain infant names for pregnant WIC participants	Birth date Family ID[c] Infant name SSN Address County	n.a.
Food instrument records, pregnant women (issuance and redemption)	Obtain measures of WIC participation (food instrument redemption)	Participant ID[d] Food instrument ID Issue date Begin date Redeem date	Status code Rejection code Estimated amount Maximum value Amount paid Food package code Item code
Vital Records			
Births	Obtain mother's demographic information and characteristics of birth	Child name Child date of birth Child sex Facility name Mother name Mother SSN Address County Medicaid payment Received WIC during pregnancy	Mother's --Education --Race/ethnicity --Prenatal care --Pregnancy weight gain --Smoking --Birth history --Risk factors --Foreign born --Marital status Newborn's --Birthweight --Gestation --Plurality --Abnormalities Birthplace type Rural residence (derived from address)

Data source	Purpose	Data elements: For record selection and file linkage	Data elements: For analysis
Fetal deaths	Removed women with fetal deaths from the analysis sample	Mother name Mother SSN Date of death Facility name Address County Medicaid payment	n.a.
Deaths	Identify deaths for infants within first year of life	Child name Child date of birth Child sex Address Mother's name	Date of death

Note: For a complete list of outcomes and characteristics included in the prenatal analysis, refer to Chapter III, Tables III.3 and III.4.

[a] If the Medicaid eligibility system is not integrated with systems for these other programs, it will be necessary to involve other agencies to obtain this information.

[b] The WIC Minimum Data Set is a set of 25 data items reported biannually on even numbered years to the WIC Participant and Program Characteristics Study (PC). The Supplemental Data Set (SDS) is a set of 11 items reported in the PC by some but not all States. For the 2010 PC report, 79 of 90 State agencies provided SDS data (Connor et al. 2011).

[c] The WIC household ID, if available, links WIC pregnant women with their infants.

[d] The WIC participant ID links enrollment records with voucher redemption records.

DRG = diagnosis-related group; ID = identification number; SNAP = Supplemental Nutrition Assistance Program; SSN = Social Security number; TANF = Temporary Assistance for Needy Families; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-I = WIC-Medicaid Study I; WM-II = WIC-Medicaid II Feasibility Study.

n.a. = not applicable.

Table B.2. Data sources and data elements for the children's analysis

Data source	Purpose	Data elements: For record selection and file linkage	Data elements: For analysis
Medicaid			
Enrollment records	Identify sample; obtain demographic information	Medicaid number Name SSN Birth date Sex Race Address County of residence Eligibility date Family size Family income Eligibility category	Participation in the SNAP and/or TANF[a]
Claims records	Measure Medicaid health care use and costs	Medicaid number Name SSN Birth date Service dates	Service dates Claim type Type of provider Provider code Diagnosis codes Procedure codes DRG codes Amount billed Amount paid by Medicaid Amount third-party liable
WIC			
Eligibility records	Identify WIC participants	Certification date Certification category Participant ID[b] Name SSN Race Sex Address	Minimum Data Set[b] First WIC certification date Number in household on WIC Termination date Termination reason code
Food instrument records (issuance and redemption)	Obtain measures of WIC participation (food instrument redemption)	Participant ID[c] Food instrument ID Issue date Valid begin date Date redeemed	Status code Rejection code Estimated amount Maximum value Amount paid Food package code Item code

Data source	Purpose	Data elements: For record selection and file linkage	Data elements: For analysis
Vital Records			
Births	Obtain mother's demographic information and characteristics of birth	Child name Child date of birth Child sex Facility name Mother name Mother SSN Address County Medicaid payment Received WIC during pregnancy	Mother's --Education --Race/ethnicity --Prenatal care --Marital status --Smoking --Birth history --Risk factors Newborn's --Date of birth --Birthweight --Gestation --Plurality --APGAR score --Abnormalities Birthplace type Rural residence (derived from address)

Note: For a complete list of outcomes and characteristics included in the children's analysis, refer to Chapter IV, Tables IV.3 and IV.4.

[a] If the Medicaid eligibility system is not integrated with systems for these other programs, it will be necessary to involve other agencies to obtain this information.

[b] The WIC Minimum Data Set is a set of 25 data items reported biannually on even numbered years to the WIC Participant and Program Characteristics Study (PC).

[c] The WIC participant ID links enrollment records with redemption records.

APGAR = appearance, pulse, grimace, activity, and respiration; DRG = diagnosis-related group; ID = identification number; SNAP = Supplemental Nutrition Assistance Program; SSN = Social Security number; TANF = Temporary Assistance for Needy Families; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

1. Variables for linking records across data files

Records were linked when specific data elements matched exactly or if a group of variables in the records likely represented the same person but did not match exactly. In either case, multiple variables were required to accurately link records. Linkage validity is known to be higher when individuals shared unique identifiers, such as Medicaid ID, WIC ID, or Social Security number (SSN). However, these types of identifiers were not always available and were subject to error (missing data, typos, fraud, and so on). Therefore, additional personally identifiable information (PII) was used as confirmatory variables in the matching process. When more linking variables were available across the files and included in the linking process, it was easier to make accurate matches. In addition, the quality of the data greatly influenced the number and accuracy of matches. Linking variables that were frequently missing or contained typos, misspellings or partial information yielded fewer, lower quality matches. The PII variables used for linking were not needed after the matching process and were dropped when the linking was completed.

The following is a general list of variables used for linking records across files.

- Administrative identifiers: SSN, Medicaid ID, WIC ID, household ID
- Names: First, middle, last, maiden, previous, alias
- Dates: Date of birth, date of death, estimated delivery date, actual delivery date
- Mailing or residence addresses (current, previous): Street address, city, State, zip code, county
- Telephone numbers: Home, work, mobile
- Demographics: Gender, race, ethnicity
- Event-based: Hospital of birth

Different combinations of linking variables were used depending on the files being linked and the sample included in the analysis. Rules for combinations of linking variables were established to determine what was considered to be sufficient for accepting a linked set of records. Section D of this appendix presents the specific variables used for each stage of the linking process in WM-II.

2. Data preparation and quality control

After receiving data extracts from individual State agencies, the study team performed extensive quality control (QC) checks to verify the quality of the data. Ongoing QC checks of both the data and the programs used to process the data ensured the integrity of the linked database. Extensive QC was particularly important for WM-II because the linking process, described in the next two sections, included numerous sequential data processing steps.

The following types of documentation, QC checks, and reports were produced when processing the original data files that develop the linked database:

- **Logged receipt of data files.** All files received from the State agencies were logged in a central system. The date of receipt, file names, and file sizes were tracked.

- **Checked sample sizes.** The record count and number of data items were checked to ensure the files matched the data request. Unique program IDs, record counts, and data documentation were verified.
- **Examined data item distributions.** For each file, frequencies of categorical variables and distributions (means, minimum, maximum, and so on) of numerical variables were tabulated. For categorical variables, the documentation of all necessary code definitions was confirmed. For numeric variables, extreme values were examined and missing values (for example, 0-fills and 9-fills) were converted to a standard missing value.
- **Examined files for completeness.** We confirmed that the agency provided complete data and did not inadvertently exclude a portion of the sample or requested time period.
- **Prepared summary report.** We prepared a summary report that included the number of records, number of unique cases, ranges for numeric variables, and distribution of categorical variables.

B. Key steps within each stage of matching

Linking WIC, Medicaid, and Vital Records data files required four matching stages. In Stage 1, all Medicaid and WIC eligibility files received a unique ID for all duplicate records. Stage 2 was performed for the prenatal analysis only. In this stage intra-agency matching linked Medicaid records for mothers and infants, WIC data for mothers and infants, and Vital Records data for birth and death certificates. In Stage 3, the Medicaid data were linked to the Vital Records data. In the fourth and final stage, matched Medicaid–Vital Records data were linked to WIC data. These four stages of matching are discussed more in Section C. This section discusses the key steps used to match files in each stage.

KEY LINKING TERMS:

Mother-infant dyads:
- A uniquely matched pair of a mother and an infant.

Types of Matching

Deterministic matching:
- Identifies matches between records when specific data elements match exactly.

Probabilistic matching:
- Identifies matches between records based on the likelihood that a group of variables represent the same person, though variables do not have to match exactly.

Stages of Matching

De-duplication:
- Identification of people who appear in the same files with more than one ID. Records are corrected such that all records corresponding to the same person can be grouped together.

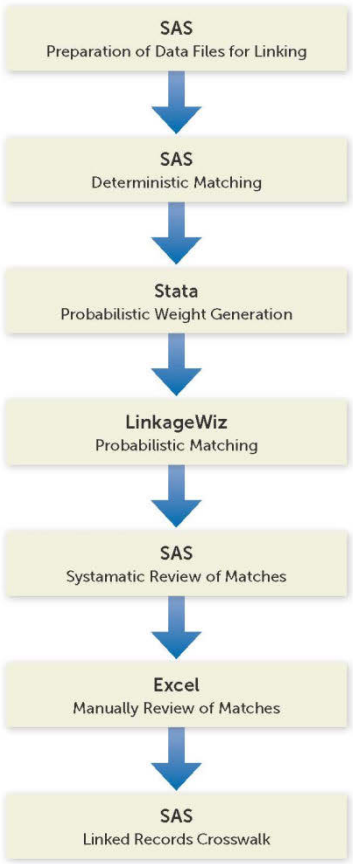
Intra-agency:
- Identification of a mother and an infant records within one agency to create a matched mother-infant dyad.

Inter-agency:
- Identification of individuals or mother-infant dyads across multiple agencies to create a multi-agency matched record.

Although the input files varied, the same series of steps were performed within each of the four matching stages. To maximize efficiency, these steps were performed using a combination of SAS, Stata, Microsoft Excel, and LinkageWiz. Unless otherwise noted, each matching stage included the following steps (Figure B.1):

- **Preparation of data files for linking.** Data were prepared for linking tasks by renaming variables to match across files and to standardize variables (described in Section B.1). In addition, IDs from prior linking stages were applied to the data so each new linking stage reflected work done in prior stages. This task was performed using SAS code.
- **Deterministic matching.** SAS was used to deterministically link records within or across files (described in Section B.2.a). All deterministically matched records received an ID number to reflect this link. Files were exported to a text file (.txt format) for later use in Stata and LinkageWiz.
- **Probabilistic weight generation and matching.** After deterministic matching, we attempted to link records through probabilistic matching (described in Section B.2.b). The probabilistic matching method used weighted scores to identify matches based on the likelihood that the variables used in matching identified a unique individual. First, we wrote a Stata program to generate weights for each variable used for probabilistic matching. We then loaded these weights and the data files into LinkageWiz, which was the software used to run probabilistic matching.
- **Systematic review of matches.** To review deterministic and probabilistic matches, rules were created in SAS to automatically accept or reject matches. Matches that could not be automatically accepted or rejected were exported to an Excel file for manual review (described in Section B.2.c).
- **Manual review of matches.** Staff manually reviewed matches that did not meet any automatic acceptance or rejection rules (described in Section B.2.c). Matches considered acceptable were flagged and kept together. Conversely, matches considered unacceptable were flagged and broken apart. Staff used Excel functions such as conditional formatting and workbook sharing to ease the burden of manual review.
- **Linked records crosswalk.** At the end of each linking stage, SAS was used to create a crosswalk of linked records (described in Section B.2.d). All records within a set of linked records received the same crosswalk ID. At each subsequent stage of linking, crosswalks were updated to reflect any new information provided by the link.

Figure B.1. Data linking steps and corresponding software



1. Data file preparation

Before linking the records, we carefully cleaned and prepared the original data files for linking. This involved assigning record numbers and data cleaning and standardization.

a. Record numbers

A unique record or row number was assigned to all Vital Records (birth certificates, fetal death certificates, and death certificates) records during the initial data processing. This was done by numbering the rows of the data from 1 to *N* (where *N* is the total number of records in the file). On the WIC and Medicaid files, record numbers were given to pure duplicates in the de-duplication stage of matching. In addition, data were restricted to the population of interest with care taken to avoid inadvertently removing records from the file (for example, a typo in an infant's date of birth did not cause the exclusion of that infant).

b. Data cleaning and standardization

After high-level diagnostics were completed and record numbers were assigned, variables used for linking were cleaned and standardized across files. That is, the same variable was named and stored in the same way in all data files. In addition, programmers used the SAS functions LENGTH, UPCASE, TRIM, LEFT, and COMPRESS to standardize character variables.

Lastly, any recoding schemes for categorical variables were developed and applied. For example, we used a consistent coding scheme for race variables across Medicaid, WIC, and Vital Records file.

2. Deterministic and probabilistic data matching

Data linkage began upon the completion of data preparation. Two common approaches to data linking are deterministic matching and probabilistic matching. These two methods are not mutually exclusive and we opted to use a hybrid approach—that is, deterministic and probabilistic matching used in conjunction with one another—to enhance matching results. Table B.3 provides a simple example of using deterministic and probabilistic matching sequentially to match three records.

Table B.3. Example of combining deterministic and probabilistic matching

Probabilistic matching variables							
Deterministic matching variables							
SSN	Last name	DOB	County	Deterministic match ID	Gender	Hispanic	Probabilistic match ID
999-99-9999	Smith	01/01/1981	Adams	D111	--	--	P111
999-99-9999	Smith	01/01/1981	Adams	D111	F	Y	P111
--	Smith	01/01/1981	Adams	D222	F	Y	P111

DOB = date of birth; F = female; ID = identification number; SSN = Social Security number; Y = yes.

a. Deterministic matching

Deterministic matching required observations to match exactly on several variables (Table B.4 shows examples). In combination, these variables uniquely identified individuals or mother-infant dyads. Though the quality of the match was higher among data sets that had unique identifiers such as SSNs, the unique identifiers sometimes had errors. Therefore, we used confirmatory variables to ensure the accuracy of the match. Criteria for deterministic matching were relatively strict because the variables selected resulted in automatic acceptance of matches as true matches.

Table B.4. Examples of deterministic matching variables

Matching stage	Matching variable
De-duplication of file	SSN, date of birth, last name, county of residence
Linking mothers to infants	Family ID, date of delivery/infant date of birth, last name, county, hospital of birth
Linking Medicaid and WIC mother-infant dyads to Vital Records	Infant first name, infant last name, infant date of birth, mother SSN, mother date of birth, mother last name, hospital of birth, county of residence

ID = Identification number; SSN = Social Security Number; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Deterministic matching was a relatively simple process performed in SAS. To perform deterministic matching, we stacked and sorted data by deterministic matching variables when linking within one file (de-duplication, described in Section C) and by merging by deterministic matching variables when linking across multiple files (intra- and inter-agency linking, also described in Section C).

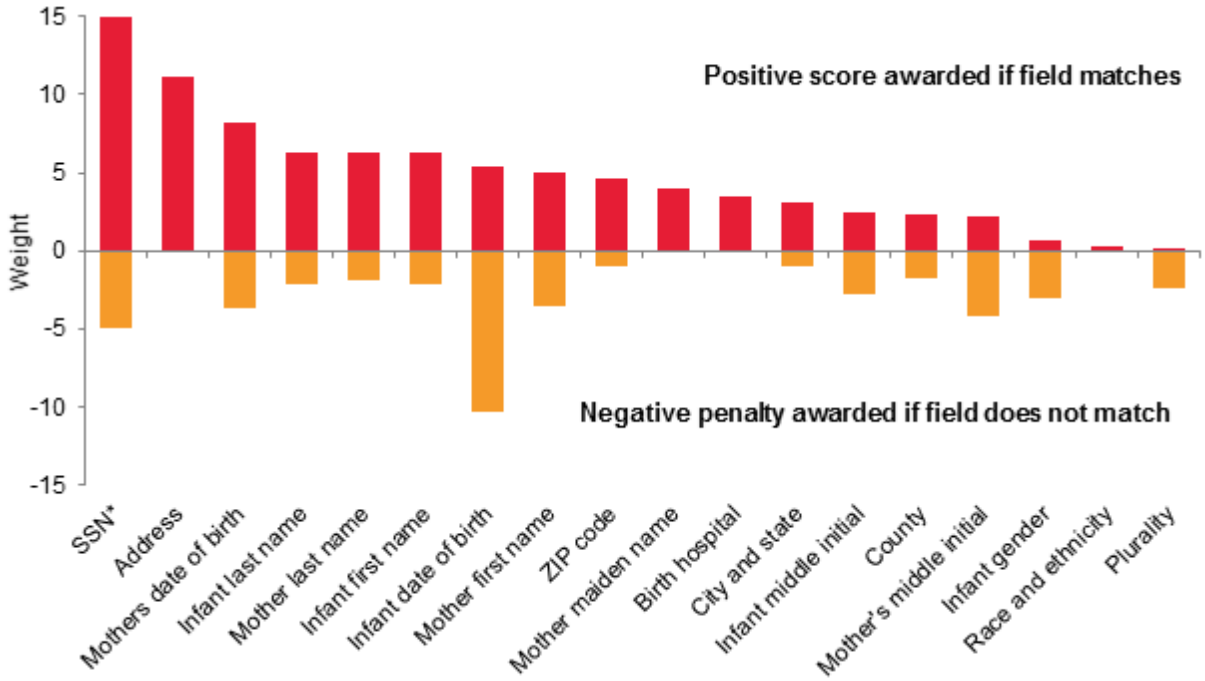
b. Probabilistic matching

The probabilistic matching method (also known as stochastic or fuzzy matching) used weighted scores to identify matches based on the likelihood that the variables used in matching identified a unique individual. Probabilistic matching was used to increase the match rate and because of the potential for data errors in PII (misspellings, truncations, and typos). The study team selected LinkageWiz to perform probabilistic matching.

For probabilistic matching within one file (de-duplication), each record was paired with every other record within the file. Across two files (intra- and inter-agency linking), every record in the first file was paired with every record in the second file. We assigned each pair of records a probabilistic match score based on whether the linking variables contained the same value and on the weights assigned to the linking variables. Each matching variable had a positive agreement weight (score) and a negative disagreement weight (penalty). Larger weights were assigned to variables that were more specific and therefore more likely to uniquely identify individuals (date of birth and household name), whereas smaller weights were assigned to variables that were less likely to uniquely identify individuals (sex, race, and county of residence). Unique identifiers, such as SSN, were assigned large scores and large penalties. In cases in which deterministically matched records were included in probabilistic matching, the maximum weight allowed by LinkageWiz was given to the deterministic matching ID to ensure records deterministically linked would remain linked. A sum of the scores and penalties assigned to the matching variables determined the total probabilistic matching score. Matches with higher total scores were considered more likely to be true matches than matches with lower total scores.

Although LinkageWiz contained default weights, these weights did not reflect the data being matched. Stata was used to generate weights that reflected the data at each linking stage. Figure B.2 shows the average weights (scores and penalties) used for the prenatal analysis. The mother's SSN, address, and date of birth were given the largest agreement scores because they were the most helpful at identifying a good match. Conversely, infant's date of birth received the largest disagreement penalty because it was the most helpful at identifying bad matches. Infant's gender, mother's race and ethnicity, and the plurality indicator had small weights because they were not particularly helpful at identifying good or bad matches.

Figure B.2. Average agreement scores and disagreement penalties for probabilistic matching variables in the inter-agency link of Medicaid to Vital Records (prenatal analysis)



Note: This figure presents weights used in the probabilistic matching algorithm for linking mother–infant dyads in the Medicaid files to the Vital Records files (birth certificates and fetal death certificates). For each field, the figure plots two weights: (1) a positive score that is awarded if the field is identical for a potential match pair (red bars facing upward) and (2) a negative penalty that is deducted if they are not (orange bars facing downward).

These weights were calculated by comparing records in the data set and calculating the proportion of pairs in which a field matched, separately for pairs in which the SSN matched (P_1) and pairs in which the SSN did not match (P_2). The score and penalty were then calculated as follows: $Score = \log_2(P_1/P_2)$ and $Penalty = \log_2\left((1-P_1)/(1-P_2)\right)$. This weighting system is based on Fellegi and Sunter (1969). Herzog et al. (2007, chapters 8–9) provide an overview of the method.

In practice, the weighting scheme actually used in the matching process varied from State to State and was more complicated (for example, we awarded scores for partial matches on names and gave higher scores to uncommon last names and lower scores to more common names). The weights also differed for linking children in the children's analysis. However, this figure provides an indication of the relative importance of each variable in the probabilistic matching algorithm.

* The score and penalty for the SSN field were arbitrarily set to +15 and -5, respectively. The SSN field was used to calculate the weights for the other fields; thus, the weights for this field could not be estimated.

SSN = Social Security number.

LinkageWiz automatically rejected matches that did not meet a defined scoring threshold. Again, LinkageWiz provided a default value for the scoring threshold, but we opted to adjust the score to better reflect the underlying data. To do so, we first ran a 10 percent random sample through LinkageWiz with the lowest possible threshold score. This resulted in many matches, including very bad matches. Next, we analyzed these results to identify the score below which a vast number of matches could be easily rejected as bad matches. After the threshold score was established, LinkageWiz was run on the full sample.

Depending on the size of the files, probabilistic matching can take a significant amount of time. To reduce processing time, data were blocked on several variables. Only records with the same value for the blocked variable were compared with every other record that had the same value for the blocked variable. For example, if records were blocked on last name, records with the last name SMITH were compared only with other SMITHs; records with different last names were not compared within that block. Similarly, blocking on county of residence would cause comparisons only of records in the same county. To avoid false or missed matches, data were blocked multiple times using different variables. Table B.5 provides examples of blocking variable for different stages of linking.

Table B.5. Examples of blocking variables for probabilistic matching

Type of match	Blocking variables
WIC mothers to WIC infants	Family name; hospital of birth+1st character of last name; WIC agency + 1st letter of last name; WIC household ID; date of birth/date of delivery; street address
Child Medicaid/Vital Records to Child WIC records	Date of birth; year of birth + last 4 digits of SSN; county + month of birth + 1st three characters of last name; street address; Medicaid ID; SSN

ID = identification number; SSN = Social Security number; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

As expected, probabilistic matching identified good links that the deterministic step did not capture. However, unlike deterministic matching, probabilistic matching yielded some false matches as well. In particular, probabilistic matching was less accurate when individuals in the data file shared many of the same values for matching variables. For example, twins and other multiple births were usually linked within the same probabilistic matching group because last names, address information, and demographic information were identical. These cases were later broken apart in the systematic or manual review process, which we discuss in the next section.

c. Review of matches

After each probabilistic matching step, as discussed previously, we used a combination of review methods to determine if the matched records were accurately grouped. In essence, matched records were placed into one of three categories: (1) strong matches to be automatically kept, (2) weak matches to be automatically dropped, and (3) mediocre matches to be manually reviewed. We chose to use conservative criteria for automatically keeping or dropping records, leaving a relatively large number of records for further review. Therefore, we performed both a systematic and manual review before considering links final.

i. Systematic review of matches

We used a systematic approach to reduce the burden of reviewing thousands of matches. This type of review worked well for strong and weak matches because they were easily defined. Specifically, we wrote a SAS program to evaluate groups using a set of rules that automatically accepted or rejected records within a group. Table B.6 shows examples of rules used at different matching stages. Matches not captured by one of these rules were sent on to the manual review process.

Table B.6. Examples of rules for accepting or rejecting matches

Stage of matching	Accept or reject	Rule
De-duplication	Accept	Probabilistic matching score above a specified threshold and SSN is nonmissing and matches
De-duplication	Reject	Last name, street address, and zip code match, but first name and date of birth do not match
Intra-agency match	Accept	Last name, delivery date, and address match
Intra-agency match	Reject	Last name and delivery date do not match
Inter-agency match	Accept	Infant's first and last names, infant's date of birth, and mother's SSN match
Inter-agency match	Reject	Infant's last name matches but first name and date of birth do not match

SSN = Social Security number.

ii. Manual review of matches

Matches that could not be systematically accepted or rejected (about 5 percent per file) based on the rules established in the SAS program were output to an Excel file for manual review. The Excel file included all of the matching variables from both records, side by side, in the linked pair. A team member then reviewed this information and evaluated whether the match was acceptable. An indicator flag (1/0) was populated within the Excel file to show the groups to keep and the groups to break apart.

The manual review files included several hundred to several thousand groups. Therefore, we used conditional formatting and workbook sharing to aid the review process and make it more efficient. For example, we used color coding to show when matching variables, such as last name and date of birth, matched exactly across the two files. When applied to the whole file, this formatting reduced the time and strain of comparing every single cell for a given pair.

d. Linked records crosswalks

After reviewing and finalizing all matches, we saved data linking results by assigning an ID at the end of each matching stage. This ID variable determined the eligibility records that were part of the linked group at that particular point in the database construction process. This file served as a crosswalk because IDs for each stage of the linking process were retained to enable programmers to always link back to the original files. At each stage of matching, we updated and improved the ID crosswalks to reflect additional information. Each stage of the linking process revealed errors or omissions in previous steps that had to be corrected. For example, two infants marked as the same person early in the matching process matched to different mothers later in the matching process. This new information led the programmer to correct the infants' IDs. Conversely, when matching Medicaid and Vital Records to WIC, WIC information linked to two children who were not previously matched. This information led the programmer to combine a pair of records that were not previously linked. At the end of the linking process, a final crosswalk was created and used for analysis files.

C. Four stages of data matching

The creation of a linked database of WIC, Medicaid, and Vital Records required multiple matching stages. We used four major linkage stages to create the database:

1. De-duplication
2. Intra-agency linking for Medicaid and WIC mothers and infants
3. Inter-agency linking between Medicaid and Vital Records
4. Inter-agency linking between Medicaid-Vital Records and WIC

Figure B.3 provides an overview of the entire linking process for the prenatal analysis. Figure B.4 shows the linking process for the children's analysis, which does not require intra-agency linking. After all the files were cleaned, those files for Medicaid mothers, infants, and children and WIC mothers, infants, and children were de-duplicated. Next, for the prenatal analysis, the Medicaid data for mothers and infants were linked to create dyads, as were the WIC data for mothers and infants and Vital Records birth certificates and death certificates (intra-agency linking). Then, the Medicaid data were linked to the Vital Records data (inter-agency linking). Finally, the resulting matched Medicaid-Vital Records data were linked to the WIC data. At each stage, researchers used the deterministic and probabilistic matching methods, reviewed matches, and created crosswalks. Note that not all files required de-duplication and intra-agency linking. For example, Vital Records files did not require de-duplication, because there was always one record per person. In addition, the children's analysis did not require intra-agency linking.

Stage 1. De-duplication

Medicaid and WIC administrative data files contained multiple records (rows in the data set) for the same person because of data changes (for example, a change of address or recertification) or corrections of data errors (such as misspellings). It was determined that the data linkage would be more successful at finding matches in other files if we used all the information available. For example, a mother might have two addresses in the Medicaid files; because we would not know in advance which of the two addresses would appear on the birth certificate. Thus, we opted to use all available addresses in the linkage process.

Before linking across data files, we created an ID within each data file to identify all of an individual's records. Even though Medicaid and WIC files have at least one unique identifier (SSN, Medicaid ID, or WIC ID), the identifier was not always reliable. For example, some records were missing SSN for an individual but not others, or some individuals were assigned multiple Medicaid IDs. De-duplication of the ID variables identified individuals for whom PII changed over time. Additionally, de-duplication helped identify individuals who were assigned a common unique ID but were not the same individual. A more accurate ID was developed for subsequent stages and steps of the record linkage process. De-duplication of IDs was not performed on Vital Records files because there was only one birth, fetal death, or death certificate per mother–infant dyad.

Figure B.3. Overview of record linkage process for the prenatal analysis

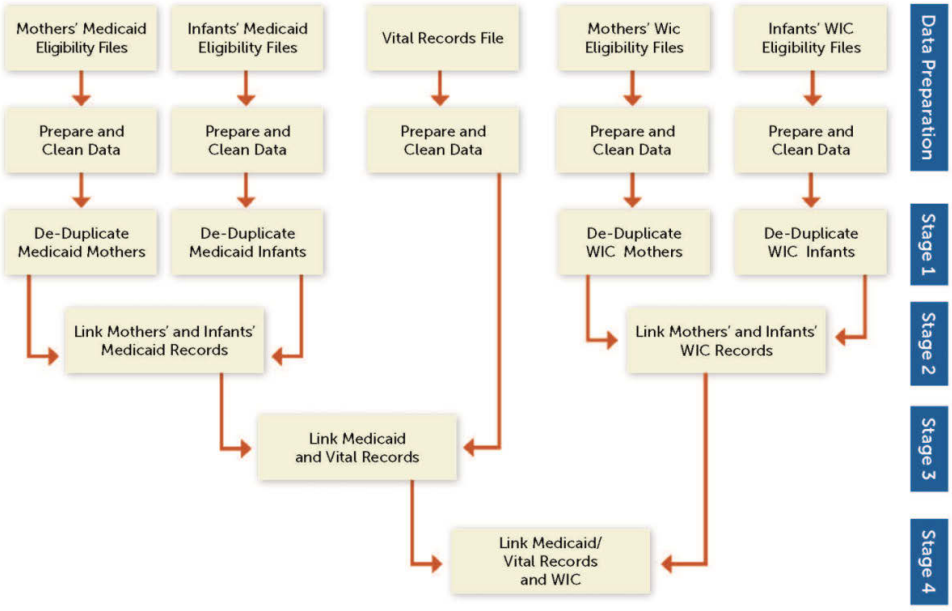
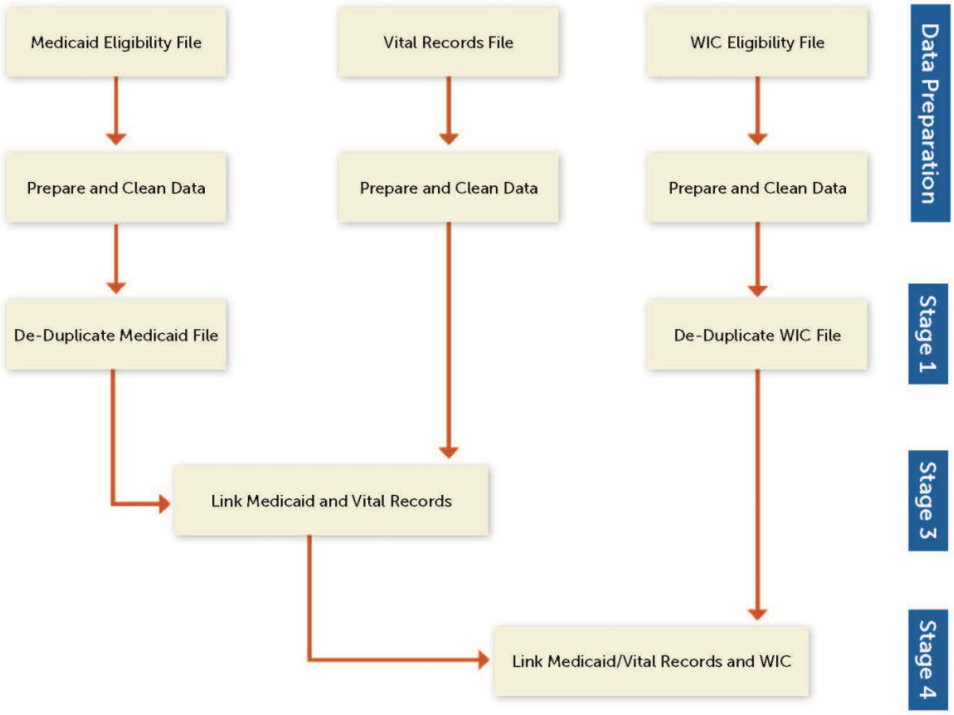


Figure B.4. Overview of record linkage process for the children's analysis



Note: The children's analysis did not require Stage 2, intra-agency linking.

De-duplication of IDs was performed by first checking for cases in which all the variables that would be used in probabilistic matching (mostly PII) were the same for an individual. These individuals often had multiple records in the file because program variables, such as eligibility

dates, differed. Therefore, all records with identical matching variables were considered pure duplicates and given the same record number ID (as discussed earlier). Only one record from each set of pure duplicates was kept in the file for matching. Second, IDs were de-duplicated using deterministic and probabilistic matching methods. Instead of matching two separate files, de-duplication involved matching a file to itself. At the end of the de-duplication process, records for each person were linked with a newly created ID variable. It is important to note that records for twins and siblings were more difficult to de-duplicate and match because they typically shared many variables with identical values, including last name, date of birth (for twins and other multiple births), case ID, address, telephone number, and race and ethnicity. Table B.7 shows the variables used for deterministic and probabilistic matching and blocking during the de-duplication stage.

Table B.7. Variables for de-duplication of eligibility files for WM-II (prenatal and children's analysis)

Variables	Medicaid files[a]	WIC files[a]
Deterministic matching variables		
SSN/DCN	X*	X*
Date of birth	X*	X*
Last name	X*	X*
County	X	X
Probabilistic matching variables		
All deterministic match variables	X	X
Group ID from deterministic match	X	X
Medicaid ID	X*	X*
WIC ID		X
First name	X	X
Middle initial	X	X
Street address	X	X
City and State	X	X
Zip code (5 digits)	X	X
Phone	X[b]	X
Gender	X	X
Race	X	
Ethnicity (Hispanic 0/1)	X[c]	
Due date		X
Race and ethnicity		X
Additional blocking variables		
First name and year of birth	X	X
Last name as NYSIIS code	X	

* Variable used in blocking for probabilistic matching.

[a] Mother, infant, and children eligibility files in Oklahoma and Missouri.

[b] Oklahoma only; Missouri file did not have telephone numbers.

[c] Ethnicity was not available on the Missouri Medicaid files at the de-duplication stage.

DCN = Missouri HealthNet ID; ID = identification number; NYSIIS = New York State Identification and Intelligence System phonetic code; SSN = Social Security number; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Stage 2. Intra-agency matching

Intra-agency linking was performed to link data files from the same agency for the prenatal analysis only. Medicaid mothers were linked to Medicaid infants, WIC mothers were linked to WIC infants, and Vital Records birth certificates were linked to Vital Records death certificates.

Linking mothers to their infants in the Medicaid and WIC files improved the linkage to Vital Records data (inter-agency linking is described in the next section). For example, match rates were higher when Jane Doe and her son John Doe were linked to the birth certificate using both names than when linking the mother to the birth certificate using only the mother's name. Furthermore, the address for the mother in the Medicaid data did not always match the address on the birth certificate, but the address of the infant often did match. Many mothers and infants were linked at this stage (more than 90 percent), but there were some unmatched mothers and infants. For Medicaid, all three of these groups were passed through to the inter-agency linkage stage. For WIC, mother-infant dyads and unmatched mothers passed through to the inter-agency linkage stage.

Matching variables were selected based on variables common across files. This stage of linking aimed to leverage household identifiers (or case IDs), but it sometimes provided links between infants and mothers when household identifiers did not match because the mother and infant had other fields that matched (such as household addresses). Table B.8 shows variables used for deterministic and probabilistic matching and blocking for mother–infant dyads. Table B.9 shows variables used for linking birth certificates to fetal death certificates. Some variables that were useful in the de-duplication matching stage were not useful for an intra-agency linking stage because two separate individuals were being linked. For example, first names and gender were not used for linking mothers and infants.

Table B.8. Variables for intra-agency linking for prenatal analysis (Medicaid and WIC)

Variables	Medicaid	
	Medicaid files[a]	WIC files[a]
Deterministic matching variables		
Medicaid case number	X*	
WIC household ID number		X
DOB to date of delivery	X*	X*
Infant's last name to mother's last name	X*	
Infant's parent or guardian's last name to mother's last name		X*
County	X	X
Hospital of birth to hospital of delivery	X	
Probabilistic matching variables		
All deterministic match variables	X	X
Group ID from deterministic match	X	X
Medicaid ID	X	
WIC ID		X
Infant's last name to mother's last name	X[b]	X
Infant's parent or guardian's first name to mother's first name		X
Infant's parent or guardian's middle initial to mother's middle initial		X
Street address	X*	X*
City and State	X	X
Zip code (5 digits)	X	X
Phone	X	
Phone 1, phone 2, and Phone 3 (concatenated and space delimited)		X
WIC clinic		X
Race	X	X
Ethnicity (Hispanic 0/1)	X	X
Alternative DOB from infant's claims to date of delivery from mother's claims	X	
DOB to expected date of delivery		X
Additional blocking variables		
Hospital of birth (or delivery for mothers) and 1st letter of last name	X	
WIC agency and 1st letter of parent's last name		X

* Variable used in blocking for probabilistic matching.

[a] Mother and infant eligibility files in Oklahoma and Missouri.

[b] This variable was already used in deterministic matching for Medicaid files, but is used only in probabilistic matching for WIC files.

DOB = date of birth; ID = identification number; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Table B.9. Variables for intra-agency linking for WM-II (birth and death certificates)

Variables	Birth and death certificates
Deterministic matching variables	
Date of birth	X*
Infant's first name	X*
Infant's middle initial	X
Infant's last name	X*
Infant's gender	X
County	X
Mother's maiden name	X
Probabilistic matching variables	
All deterministic match variables	X
Group ID from deterministic match	X
Street address	X*
City and State	X
Zip code (5 digits)	X*
Race	X
Ethnicity	X
Additional blocking variables	
Infant's last name (NYSIIS)	X
County and race and 1st 3 letters of last name	X

* Variable used in blocking for probabilistic matching.

ID = identification number; NYSIIS = New York State Identification and Intelligence System phonetic code.

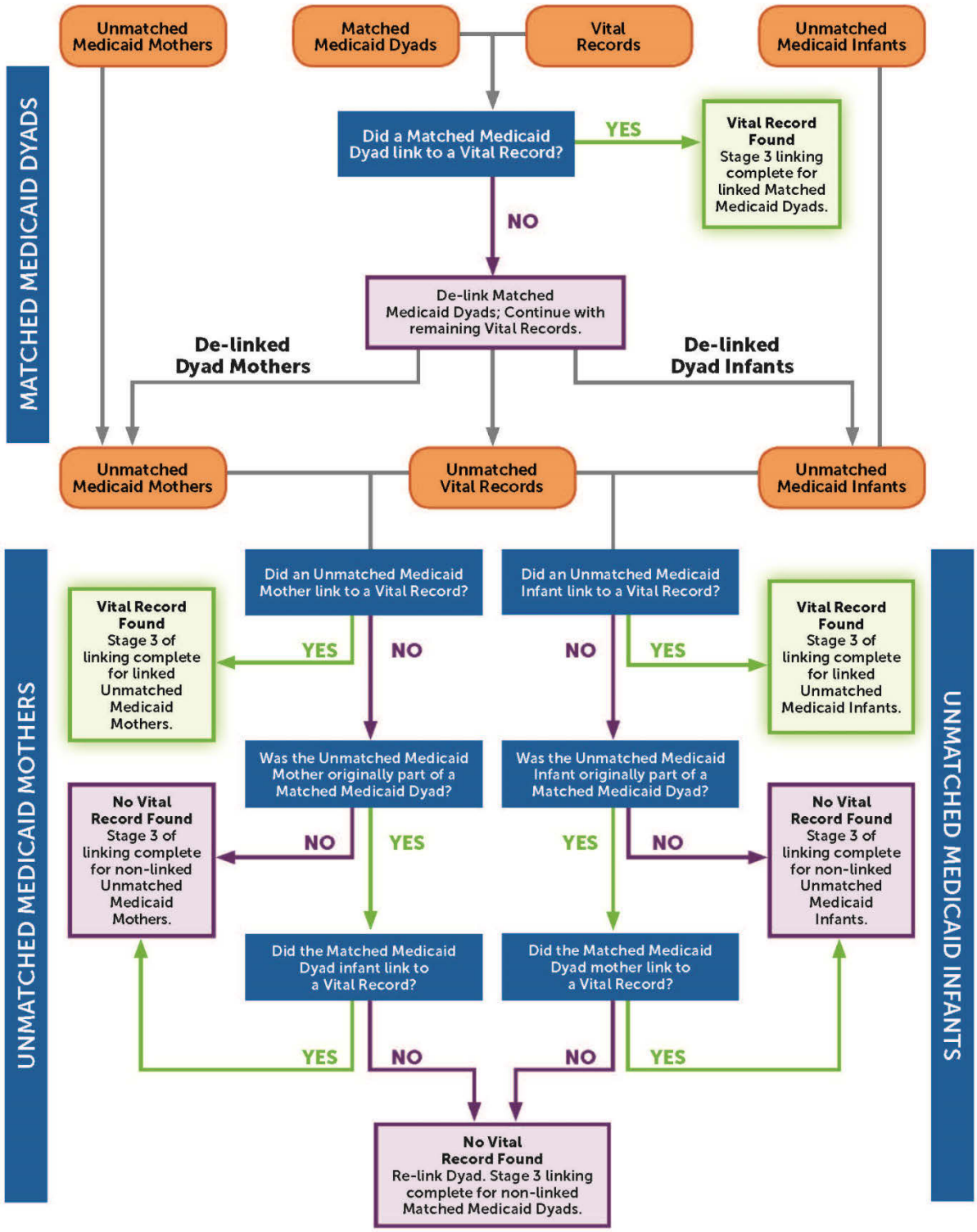
Linking birth certificates to death certificates enabled researchers to analyze infant mortality. Deterministically matched records for this match were not included in probabilistic matching because a birth certificate could not match to more than one death certificate. Because death certificates were linked for outcome variables only, this process was completed in parallel to the main linking tasks.

Stage 3. Inter-agency matching Medicaid to Vital Records

The first inter-agency matching stage linked Medicaid and Vital Records files. For the prenatal analysis, this included an iterative process in which Medicaid files were organized into three groups based on intra-agency linking results: (1) matched Medicaid dyads, (2) unmatched Medicaid mothers, and (3) unmatched Medicaid infants. Matched dyads were linked to the full Vital Records files. Medicaid dyads that did not link to Vital Records during the first iteration of inter-agency matching (matched Medicaid dyads to Vital Records) were de-linked. We attempted to link the mothers and infants from these dyads again to Vital Records during the second and third iterations of inter-agency matching (unmatched Medicaid mothers to Vital Records and unmatched Medicaid infants to Vital Records). This was done to verify that dyads were correctly linked in the intra-agency matching stage and to ensure that potential dyads were not missed because of incorrect linking in the intra-agency matching stage. The delinked dyads were relinked following matching, if the infant and mother did not link to a Vital Record during the subsequent iterations of linking. Unmatched Medicaid mothers and infants were linked to Vital Records that did not link to a matched dyad. Figure B.5 shows the process flow for linking Medicaid to Vital Records.

For the children's analysis, we performed one linking iteration. This was because dyads were not created in the children's analysis (no intra-agency stage). Therefore, Medicaid children could be linked to Vital Records without additional iterations.

Figure B.5. Inter-agency linking: Medicaid to Vital Records process flow (prenatal analysis)



a. Prenatal analysis inter-agency linking of Medicaid to Vital Records

- **Medicaid dyads linked to Vital Records birth certificates and fetal death certificates.** Birth certificates and fetal death certificates were stacked together to form one Vital Records file that we used in all subsequent stages of linking. Variables from Medicaid and Vital Records were prepared with matching names for deterministic and probabilistic matching. Deterministically matched records did not proceed to probabilistic matching because Vital Records could not match to more than one dyad. Table B.10 shows matching variables for this link.
- **Unmatched Medicaid mothers to Vital Records.** Two types of unmatched Medicaid mothers were linked to the Vital Records that were not linked to Medicaid dyads:

  Medicaid mothers who did not link to an infant during intra-agency linking

  Medicaid dyad mothers for whom a Vital Record was not found in the matched Medicaid dyads link

  Again, we created consistent variable names and deterministically matched records did not proceed to probabilistic matching because Vital Records could not match to more than one mother. New dyads were formed during this match when unmatched Medicaid mothers linked to Vital Records to which unmatched Medicaid infants were also linked. Table B.11 shows matching and blocking variables for this link.
- **Unmatched Medicaid infants linked to Vital Records**. As discussed earlier, two types of unmatched Medicaid infants were linked to the Vital Records that were not linked to Medicaid dyads:

  Medicaid infants who did not match to a mother during intra-agency linking

  Matched Medicaid dyad infants for whom a Vital Record was not found in the Matched Medicaid dyads link.

  Deterministic matching could not be performed for this link because the same unique identifier was not on both files (mother's SSN was on Vital Records, infant's Medicaid ID was on Medicaid files). All records proceeded to probabilistic matching because Vital Records could not match to more than one infant. New dyads were formed during this match when unmatched Medicaid infants linked to Vital Records to which unmatched Medicaid mothers were also linked. Table B.12 shows matching variables for this link.

b. Children's analysis inter-agency linking of Medicaid to Vital Records

- **Medicaid children linked to Vital Records birth certificates.** Variables from Medicaid and Vital Records were prepared with matching names for probabilistic matching. Deterministic matching could not be performed for this link because the same unique identifier was not on both files (mother's SSN was on Vital Records, child's Medicaid ID was on Medicaid files). Table B.10 shows matching variables for this link.

Table B.10. Variables for inter-agency linking Medicaid files to Vital Records files for WM-II (prenatal dyads and children's analysis)

Variables[a]	Prenatal files	Children's files
Deterministic matching variables[b]		
Mother's SSN	X*	n.a.
Mother's last name	X	n.a.
Mother's DOB	X*	n.a.
Infant's/child's DOB	X*	n.a.
Infant's/child's first name	X	
Infant's/child's last name	X	n.a.
Hospital/facility of birth	X	
County	X	n.a.
Probabilistic matching variables		
All Deterministic match variables	X	n.a.
Mother's first name	X	
Mother's first name to infant's/child's first name	X	
Mother's middle initial	X	
Mother's last name	X[c]	
Mother's last name to mother's maiden name	X	
Infant's/child's DOB	X*[c]	X*
Infant's/child's first name	X[c]	X
First 7 letters of infant's/child's first name	X[d]	X[d]
Infant's/child's middle initial	X	X
Infant's/child's last name	X[c]	X
Infant's/child's last name to mother's last name	X	X
Infant's/child's gender	X	X
Infant's/child's first name to mother's first name		X
Street address	X*	X*
City and State	X	X
Zip code (5 digits)	X	X
Infant's/child's race and ethnicity to mother's race and father's race and ethnicity		X
Infant's race and mother's race and Hispanic indicator to mother's race and mother's ethnicity	X	
Additional blocking variables		
Infant's/child's last name (NYSIIS) and 1st letter of first name	X	X
Infant's county and month of infant's/child's DOB and 1st three letters of last name	X	X

Note: Files included in this link for the prenatal analysis include Medicaid mother and infant files, Vital Records files, and WIC mother and infant files; for the children's analysis, files include Medicaid child files, Vital Records files, and WIC child files.

* Variable used in blocking for probabilistic matching.

[a] For variables that list more than one variable, the first variable listed comes from the Medicaid file and the second comes from the Vital Record file.

[b] Deterministic matching was not performed for the children's analysis at this stage because a unique identifier was not present on both the Medicaid and Vital Records files.

[c] Mother's last name, infant's SSN, infant's Medicaid ID, infants DOB, infant's last name, and infant's county were used as a deterministic matching variable in the prenatal analysis, but used as a probabilistic matching variable only in the children's analysis.

[d] There were truncated names in the prenatal and children's analysis files. A variable that contained the first 7 letters of the infant's or child's name was used in matching to address this issue.

DOB = date of birth; ID = identification number; NYSIIS = New York State Identification and Intelligence System phonetic code; SSN = Social Security number; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

n.a. = not applicable.

Table B.11. Variables for inter-agency linking for unmatched Medicaid mothers' files to Vital Records files

Variables[a]	Unmatched mothers' files
Deterministic matching variables	
Mother's SSN	X*
Mother's last name	X
Mother's date of birth	X*
Hospital or facility of delivery	X
County of residence	X
Probabilistic matching variables	
All deterministic match variables	X
First 7 letters of mother's first name	X
Mother's first name	X
Mother's date of delivery to infant's date of birth	X
Mother's middle initial	X
Mother's last name	X
Plurality	X
Street address	X*
City and State	X
Zip code (5 digits)	X
Mother's race	X
Mother's ethnicity	X
Fetal death	X
Additional blocking variables	
Mother's year of birth and last 4 digits of SSN	X
Mother's last name (NYSIIS)	X
Mother's race and month of mother's date of birth and 1st three characters of mother's last name	X

Note: Files included in this link for the prenatal analysis include Medicaid unmatched mothers' files and unmatched (did not match to a Medicaid dyad) Vital Records file.

* Variable used in blocking for probabilistic matching.

[a] For variables that list more than one variable, the first variable listed comes from the Medicaid file and the second comes from the Vital Record file.

NYSIIS = New York State Identification and Intelligence System phonetic code; SSN = Social Security number.

Table B.12. Variables for inter-agency linking for unmatched Medicaid infants' files to Vital Records files

Variables[a]	Unmatched infant files
Probabilistic matching variables	
Infant's date of birth	X*
Infant's first name	X
Infant's last name	X
Infant's SSN to mother's SSN	X*
Infant's claim's date of birth to infant's date of birth	X
Hospital or facility of birth	X
County of residence	X
First 7 letters of infant's first name	X
Plurality	X
Infant's middle initial	X
Infant's last name to mother's maiden name	X
Infant's first name to mother's first name	X
Infant's last name to mother's last name	X
Street address	X*
City and State	X
Zip code (5 digit)	X
Gender	X
Infant's race and ethnicity (concatenated) to mother and father's race and ethnicity (concatenated)	X
Fetal death	X
Additional blocking variables	
Infant's last name (NYSIIS) and 1st letters of first name	X
County and month of infant's date of birth and 1st three letters of last name	X

Note: Files included in this link for the prenatal analysis include Medicaid unmatched infants' files and unmatched (did not match to a Medicaid dyad) Vital Records files.

* Variable used in blocking for probabilistic matching.

[a] For variables that list more than one variable, the first variable listed comes from the Medicaid file and the second comes from the Vital Record file.

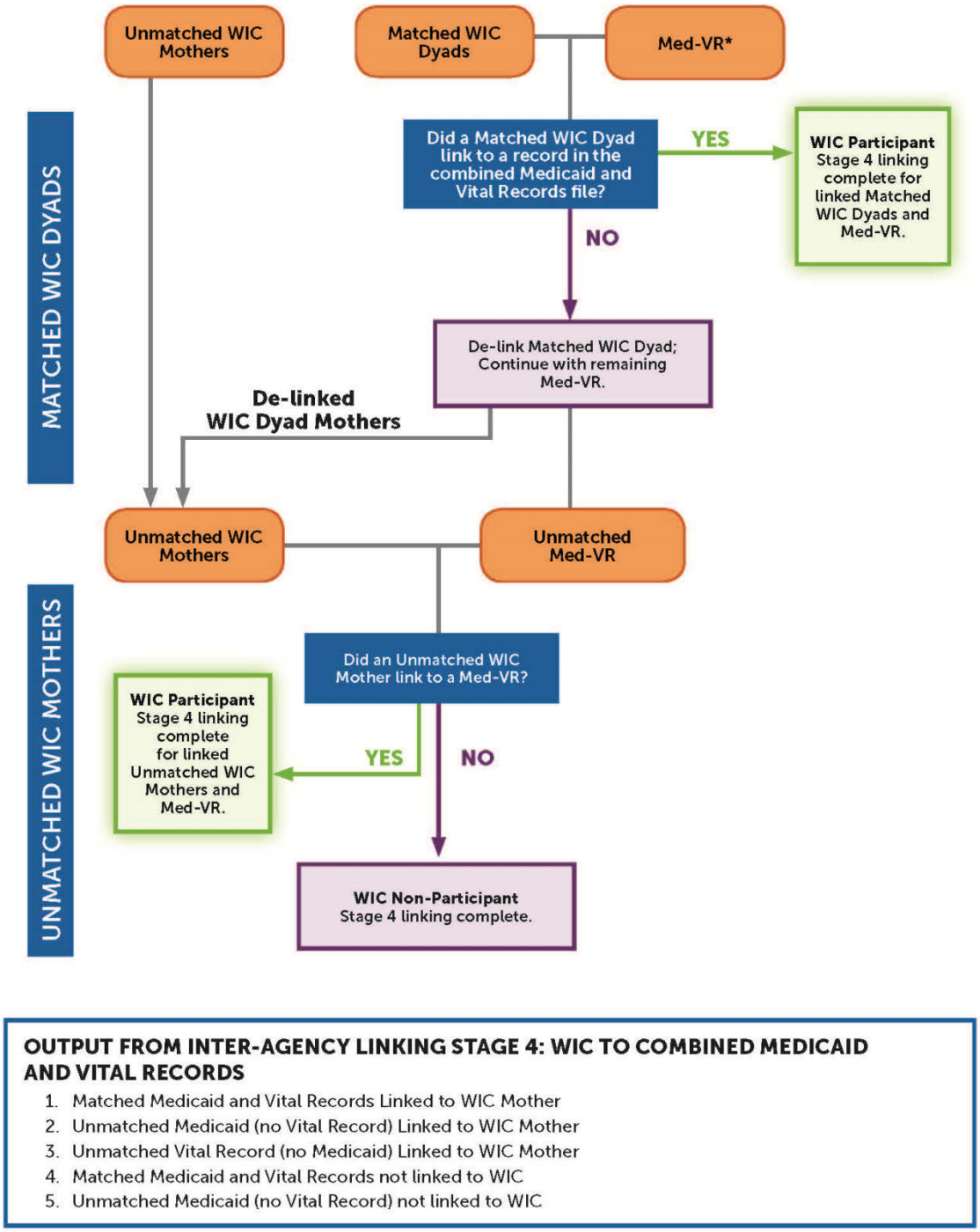
NYSIIS = New York State Identification and Intelligence System phonetic code; SSN = Social Security number.

Stage 4. Inter-agency matching Medicaid-Vital Records to WIC

The final stage involved linking WIC and a combined Medicaid and Vital Records files. This was the second inter-agency matching stage. For the prenatal analysis, this included a multistep process in which WIC files were organized into two iterations based on intra-agency linking results: (1) matched WIC dyads and (2) unmatched WIC mothers. Unmatched WIC infants were not linked during this stage because the prenatal analysis focused on mothers' participation in WIC, not the infants. Matched WIC dyads were linked to the full combined Medicaid and Vital Records file. WIC dyads that did not link to Vital Records during the first iteration of inter-agency matching (matched WIC dyads to combined Medicaid and Vital Records) were delinked. The mothers from these dyads attempted to link again to the combined Medicaid and Vital Records during the second iteration of inter-agency matching (unmatched WIC mothers to combined Medicaid and Vital Records). This was done to verify that dyads were correctly linked in the intra-agency matching stage and to ensure that potential mothers on WIC were not missed because of incorrect linking in the intra-agency matching stage. Unmatched WIC mothers were linked to combined Medicaid and Vital Records that did not link to a matched WIC dyad. Figure B.6 shows the process flow for WIC to combined Medicaid and Vital Records.

For the children's analysis, one linking step was performed. This was because dyads were not created in the children's analysis (no intra-agency stage). Therefore, WIC children could be linked to combined Medicaid and Vital Records without additional iterations.

Figure B.6. Inter-agency linking: Combined Medicaid and Vital Records to WIC process flow (prenatal analysis)



OUTPUT FROM INTER-AGENCY LINKING STAGE 4: WIC TO COMBINED MEDICAID AND VITAL RECORDS

1. Matched Medicaid and Vital Records Linked to WIC Mother
2. Unmatched Medicaid (no Vital Record) Linked to WIC Mother
3. Unmatched Vital Record (no Medicaid) Linked to WIC Mother
4. Matched Medicaid and Vital Records not linked to WIC
5. Unmatched Medicaid (no Vital Record) not linked to WIC

* File uses the output from Inter-Agency Linking Stage 1: Medicaid to Vital Records

Med-VR = Medicaid to Vital Records.

a. Prenatal analysis inter-agency linking of WIC to combined Medicaid and Vital Records

- **Removal of extraneous Medicaid records.** Before linking, extraneous records were removed from the Medicaid data set. Records removed did not match to a Vital Record in the first stage of inter-agency linking and met at least one of the following criteria:
  1. A mother's record with the same Medicaid ID and a delivery date within nine months of another record matched to Vital Records
  2. A mother or infant's record that did not match to Vital Records and did not have a birth event code in Medicaid
  3. A mother or infant's record with a delivery date before the study time frame
  4. A mother or infant's record with a delivery date after the study time frame
  5. An infant who was not eligible for Medicaid within 60 days of birth
- **Matched WIC dyads linked to combined Medicaid and Vital Records.** Information from both Medicaid and Vital Records was used when linking to WIC. Variables not common between Medicaid and Vital Records or variables that were more likely to change, such as address, were assigned to each row of the data. For example, Medicaid ID was added to rows from the Vital Records file to improve the likelihood that a WIC record would match to one of the linked Medicaid or Vital Records rows in the file. Variables from WIC were prepared to match the variables on the combined Medicaid and Vital Records file for deterministic and probabilistic matching (common variable names or common categorical coding schematics). Deterministically matched records did not proceed to probabilistic matching because Vital Records could not match to more than one dyad. Table B.13 shows matching and blocking variables for this link.
- **Unmatched WIC mothers linked to combined Medicaid and Vital Records**. As described earlier, two types of unmatched WIC mothers were linked to records from the combined Medicaid and Vital Records file that did not match to a WIC dyad:
  1. WIC mothers who did not match to an infant during intra-agency linking
  2. Matched WIC dyad mothers who did not link to a combined Medicaid and Vital Records record in the Matched WIC dyads linked to combined Medicaid and Vital Records link.

  Again, deterministically matched records did not proceed to probabilistic matching because Vital Records could not match to more than one mother. Table B.14 shows matching and blocking variables for this link.

b. Children's analysis inter-agency linking of WIC to combined Medicaid and Vital Records

- **Removal of extraneous Medicaid records.** Before linking, extraneous records were removed from the combined Vital Records and Medicaid data set. Records removed were children enrolled for fewer than 10 months of the calendar year 2010.
- **WIC children linked to combined Medicaid and Vital Records.** Information from both Medicaid and Vital Records was used when linking to WIC. Similar to the prenatal

analysis, variables not common between Medicaid and Vital Records or variables that were more likely to change, such as address, were assigned to each row of the data to improve the likelihood that a WIC record would match to one of the linked Medicaid or Vital Records rows in the file. The addition of the shared variables enabled the children's file to go through deterministic matching at this stage of inter-agency matching. WIC and the combined Medicaid and Vital Records file included a Medicaid ID. Variables from WIC were prepared to match the variables on the combined Medicaid and Vital Records file for deterministic and probabilistic matching (common variable names and categorical coding schematics). Deterministically matched records did not proceed to probabilistic matching because Vital Records could not match to more than one dyad. Table B.13 shows matching and blocking variables for this link.

Table B.13. Variables for inter-agency linking WIC files to combined Medicaid and Vital Record files (prenatal and children's analysis)

Variable[a]	Prenatal files[b]	Children's files[a]
Deterministic matching variables[a]		
Mother's SSN	X*	
Mother's Medicaid ID	X	
Mother's last name	X[c]	
Mother's DOB	X*	
Infant's/child's SSN		X*
Infant's/child's Medicaid ID	X*	X*
Infant's/child's date of birth	X*	X*
Infant's/child's last name	X	X
Infant's/child's first name	X	X
County	X	X
Probabilistic matching variables		
All deterministic match variables	X	X
Mother's first name	X	X
Mother's middle initial	X	
Mother's last name	X[c]	X
Mother's last name to mother's maiden name	X	
Infant's/child's SSN	X	X[d]
First 7 letters of child's first name		X
Infant's/child's middle initial	X	X
Infant's/child's gender[d]	X	X
Street address[e]	X*	X*
City and State[e]	X	X
Zip code (5 digits)[e]	X	X
Child's race and ethnicity		X
Mother's race and ethnicity		X
Phone 1 and phone 2 and phone 3 (concatenated)[h]	X	X
Birthweight (quantiles)[h]	X	
Fetal death	X	n.a.
Additional blocking variables		
Infant last name (NYSIIS) and 1st letter of first name	X	
Infant's/child's county and month of infant's/child's DOB and 1st three letters of last name	X	X
Child's year of birth and last 4 digits of SSN		X

Note: Matched mother–infant dyads from Medicaid eligibility records are linked to infant birth certificates and fetal death records in Oklahoma and Missouri.

* Variable used in blocking for probabilistic matching.

[a] Children's Medicaid eligibility records are linked to birth certificates in Oklahoma and Missouri.

[b] For variables that list more than one variable, the first variable listed comes from the WIC file and the second comes from the combined Medicaid and Vital Record file.

[c] Mother's last name was used as a deterministic matching variable and infant's SSN was used only as a probabilistic matching variable in the prenatal analysis, but child's SSN was used as a deterministic matching variable and mother's last name was used only as a probabilistic matching variable in the children's analysis.

[d] Missing for all fetal death certificates.

[e] Information can be used from either mother's or infant's record.

[f] Telephone numbers were concatenated to allow for additional probabilistic matching variables in LinkageWIZ.

[g] Quantiles were calculated with the combined Medicaid and Vital Records data for the prenatal analysis. A distribution of the variable was taken to identifying the minimum, 25th percentile, median, 75th percentile and maximum. Using these cutoffs, the birthweight variable was organized into four groups (on both the Medicaid and WIC data): Group 1 if between the minimum and 25th percentile, Group 2 if the 25th percentile to the median, Group 3 if median to the 75th percentile, and Group 4 if the 75th percentile to the maximum.

DOB = date of birth; ID = identification number; NYSIIS = New York State Identification and Intelligence System phonetic code; SSN = Social Security number; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

n.a. = not applicable.

Table B.14. Variables for inter-agency linking for unmatched WIC mother files to combined Medicaid and Vital Records files

Variables[a]	Unmatched WIC mothers' files
Deterministic matching variables	
Mother's SSN	X*
Mother's Medicaid ID	X*
Mother's last name	X
Mother's date of birth	X*
Actual delivery date to infant's date of birth	X*
County of residence	X
Probabilistic matching variables	
All deterministic match variables	X
Mother's first name	X
First 7 letters of mother's first name	X
Mother's middle initial	X
Mother's last name to mother's maiden name	X
Mother's participation in Medicaid	X
Mother's due date to infant's date of birth	X
Street address	X*
City and State	X
Zip code (5 digits)	X
Phone 1 and phone 2 and phone 3 (concatenated)	X
Fetal death	X
Additional blocking variables	
Mother's year of birth and last 4 digits of SSN	X
Mother's last name (NYSIIS)	X

Note: Files included in this link for the prenatal analysis include Medicaid unmatched mothers' files and unmatched (did not match to a Medicaid dyad) Vital Records file.

* Variable used in blocking for probabilistic matching.

[a] For variables that list more than one variable, the first variable listed comes from the Medicaid file and the second comes from the Vital Record file.

ID = identification number; NYSIIS = New York State Identification and Intelligence System phonetic code; SSN = Social Security number; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

D. Assessing matching results

The result of all of the linking stages was a final crosswalk file containing the IDs from the original data files and the final IDs used to identify the mother–infant dyads or individuals for analysis. The final crosswalk served two important functions. First, it was merged to Medicaid claims data and WIC food instrument data using the original IDs. Then we used the final IDs, reflecting all of the matching work, to create analysis variables for each individual. Second, we used the crosswalk to determine records to include in our analysis sample.

As described earlier, matched pairs were found and/or improved at each stage in the linking process. As more data points became available for comparison, it was possible to find new matches that were previously missed. In addition, the new information identified and fixed erroneous pairs from previous stages. After completing all of the linking stages and considering all matched pairs final, we assessed the data-linking results. Researchers examined the match rates (Table B.15) and compared the results with previous studies (WIC-Medicaid Study I; Bucher et al. 2003). We defined match rates as the percentage of singleton Medicaid-covered births linked to birth certificates.

Table B.15. Match rates for the WM-II prenatal and children analyses

	Missouri[a]	Oklahoma[b]
Prenatal analysis		
Percentage of all Medicaid mothers included in the analysis[c]	97.4	97.7
Percentage of all Medicaid newborns included in the analysis[c]	97.3	97.4
Percentage of all Medicaid dyads included in the analysis[c]	98.6	98.1
Percentage of death certificates matched	100.0	96.9
Children's analysis		
Percentage of all Medicaid children included in the analysis[d]	88.0	84.7

[a] In Missouri, 88 matched records were ultimately excluded because the birth certificates were missing data on gestational age.

[b] In Oklahoma, two of the nine Indian Tribal Organizations that provide WIC services did not participate in the study. As a consequence, 1,070 matched records were ultimately excluded to avoid misidentification of WIC participants and nonparticipants. An additional 171 matched records were excluded because the birth certificates were missing data on gestational age.

[c] Medicaid mothers, newborns, and births included in the analysis are all Medicaid-covered mothers and newborns who were matched to a Vital Records birth certificate.

[d] The total number of Medicaid-enrolled children included in the analysis includes all Medicaid children continuously enrolled during calendar year 2010 and matched to a Vital Records birth certificate.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

APPENDIX C

MEASURING PARTICIPATION IN THE SPECIAL SUPPLEMENTAL NUTRITION PROGRAM FOR WOMEN, INFANTS, AND CHILDREN IN OKLAHOMA

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It was challenging to identify Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) participants in Oklahoma, where nine Indian Tribal Organizations (ITOs) and the State provide WIC services. The services provided by these ITOs are not restricted to members of a specific tribe or to Native Americans in general. Seven of the nine ITOs in Oklahoma agreed to participate in the WIC-Medicaid II Feasibility Study (WM-II) and provided the required administrative data. However, two ITOs—Cherokee Nation and Citizen Potawatomi Nation—ultimately elected not to participate in the study. Combined, the two ITOs served about 1,200 pregnant women and 5,800 children in 2010 (Connor et al. 2011). Because we did not have complete data on WIC participation in Oklahoma, we could not assume that all of the sample members who were not found in the WIC administrative data (from the State and seven ITOs) did not participate in WIC. Some of these women and children might have participated in WIC through clinics run by the Cherokee or Citizen Potawatomi Nations. If we ignored this possibility and misclassified people who actually participated in WIC, our estimates of WIC program impacts would have been biased toward zero (that is, toward not finding an effect). In this appendix, we describe the approach we used in dealing with the missing WIC administrative records and discuss implications for the internal and external validity of our resulting impact estimates.

The Cherokee Nation jurisdiction spans six full and eight partial counties in the northeastern part of Oklahoma, and the Citizen Potawatomi Nation jurisdiction includes seven counties in central Oklahoma.[2] However, State-affiliated (that is, non-ITO) WIC clinics and, possibly, other ITOs also serve all of these counties. To avoid misclassifying women who enrolled in WIC through a Cherokee or Citizen Potawatomi Nation clinic as nonparticipants, we excluded from the analysis groups of women and children who were most likely to enroll in WIC through a Cherokee or Citizen Potawatomi Nation clinic. We identified these groups based on the proximity of their residence to a clinic run by the Cherokee or Citizen Potawatomi Nation. We next provide the details of our approach, separately for the prenatal and children's analyses.

A. Prenatal analysis

In this section, we first present the steps we took to group women based on the likelihood that they enrolled in WIC through a Cherokee or Citizen Potawatomi Nation clinic. The categories are based on the women's zip code of residence. We then compare WIC participation rates as reported on the birth certificate with WIC participation rates based on linked WIC administrative records across the different categories. Finally, we present the methods we used in identifying groups of women excluded from the analysis.

Step 1. Categorize women according to distance to nearest Cherokee or Potawatomi WIC clinic

If women enroll in WIC through the most conveniently located clinic, then the likelihood that we have the associated WIC administrative records for WIC participants depends on the proximity of their residences to WIC clinics run by the various entities (State-affiliated local WIC agencies [LWAs], participating ITOs, and Cherokee or Potawatomi ITOs). By this assumption, we should have the most complete data for women who live in areas that are far

[2] Anyone in Oklahoma can enroll through a tribal agency irrespective of race or place of residence (Source: personal communication with Cherokee Nation WIC director).

from a Cherokee or Potawatomi agency clinic, and who live near clinics run by participating ITOs or State-affiliated LWAs. On the other hand, we most likely have incomplete WIC records for women who live near a Cherokee or Potawatomi clinic. To assess how the rate of WIC participation based on available WIC records varies by women's residences, we created the following categories to reflect distance between women's places of residence and the nearest WIC clinic:

Group A: Closest clinic is a State-affiliated LWA or participating ITO clinic, and no Cherokee or Potawatomi clinic is within 10 miles of the zip code of residence

Group B: Closest clinic is a State-affiliated LWA or participating ITO clinic, but a Cherokee or Potawatomi clinic is within 10 miles of the zip code of residence

Group C: There is equal distance between the zip code of residence and State-affiliated LWA, participating ITO, and Cherokee/Potawatomi clinics

Group D: The closest clinic is a Cherokee or Potawatomi clinic

Ideally, we would have grouped women based on their residences during pregnancy. However, we did not have information for all possible addresses where women resided during their pregnancies. Their addresses at birth as reported on the birth certificates were used as a proxy. For each woman, we calculated the distance from the residence as reported at the time of birth to the nearest State or other ITO WIC clinic and the distance to the nearest Cherokee or Potawatomi clinic using (1) the longitude and latitude of the population centroid of the zip code of residence and (2) the longitude and latitude of all zip codes that have a WIC clinic in Oklahoma. We obtained the clinic zip codes from the most recent list available on the Oklahoma State Department of Health website, the websites of Oklahoma American Indian areas, and the Food and Nutrition Service website.

Step 2. Compare WIC participation rates based on self-reported and WIC administrative records, by geographic groups and women's race

We next compared the proportion of women who linked to a WIC administrative record with the proportion who reported participating in WIC on the birth certificate within the four geographic categories (Groups A–D, above). We used this information to assess how many women were prone to misclassification because of missing WIC administrative data. Because there might be a stronger preference among Native Americans to enroll in an ITO-run clinic, irrespective of the distance, we further categorized women based on their race as reported on the birth certificate (Native American or non-Native American).

Table C.1 presents cross-tabulations of women's self-reported WIC participation (from the birth certificate) with WIC participation based on WIC administrative records. Data are presented separately for each geographic group and by race. The first panel presents data for women in Group A—women who lived in areas close to a State-affiliated LWA or participating ITO clinic and far from a Cherokee or Potawatomi clinic. As shown, 92.2 percent of non-Native American women and 85.1 percent of Native American women who reported WIC participation on the birth certificate also linked to a WIC administrative record. See the numbers in the cell for "Yes" for WIC from (reported on) birth certificate (BC) and "Yes" for linked to WIC

administrative record. Among women who reported (on the birth certificate) that they did not participate in WIC, the proportion who did not link to a WIC administrative record is somewhat lower—81.4 percent for non-Native Americans and 82.1 percent for Native Americans. See the numbers in the cell for "No" WIC from (reported on) birth certificate (BC) and "No" for linked to WIC administrative record.

Thus, the rate of agreement between self-reported WIC participation and participation based on WIC administrative records was not 100 percent for women in Group A. This was not unexpected, as self-reported measures of program participation are less reliable than measures based on administrative data. This match rate, however, is likely based on complete WIC administrative data (because these women did not live near a Cherokee or Potawatomi clinic). Therefore, we used this as the benchmark match rate and compared it with the rates among women in Groups B, C, and D, for whom we most likely did not have complete WIC records.

In the second panel of Table C.1, we present WIC participation rates for women in Group B—those for whom the closest clinic is a State-affiliated LWA or participating ITO clinic, but a Cherokee or Potawatomi clinic is within a 10 mile radius. For both non-Native American and Native American women in Group B, there was less consistency than among Group A women[OK? needs a comparison] between WIC participation as reported on the birth certificate and WIC participation observed in the administrative data. Among non-Native Americans, 85.4 percent of women who reported WIC participation on the birth certificate were linked to a WIC record, a match rate that is about 6.8 percentage points lower than the match rate in Group A. This suggests that about 6.8 percent (or 19) of the non-Native American women in Group B who reported (on the birth certificate) that they participated in WIC, likely enrolled through a Cherokee or Potawatomi clinic and, therefore, we do not have WIC records for them. On the other hand, 83.3 percent of non-Native American women in Group B who reported that they did not participate in WIC did not link to a WIC record—a match rate that is slightly higher (1.9 percentage points) than the benchmark rate of 81.4 percent. This suggests that only about 1.9 percent of non-Native American women in Group B who reported (on the birth certificate) that they did not participate in WIC actually enrolled through a Cherokee or Potawatomi clinic.

The differences between the benchmark match rates and the match rates we observed among women in Groups C and D were even larger. For all three groups (B, C, and D), there was less consistency between self-reported WIC participation and WIC participation based on administrative records among Native American women compared with non-Native Americans.

Step 3. Handling missing WIC records from Cherokee Nation and Citizen Potawatomi nation WIC agencies

As noted previously, misclassifying WIC participants as nonparticipants because of missing WIC administrative data would have biased our estimates of WIC impacts toward zero. Columns 4 and 8 of Table C.1, present our estimates of the number and percentage of women in Groups B, C, and D who would likely have been misclassified as nonparticipants because they enrolled in WIC through a Cherokee or Potawatomi clinic. For example, among women in Group D—those living close to a Cherokee or Potawatomi clinic—79.3 percent of the non-Native American women who reported that they participated in WIC linked to a WIC record and 20.7 percent did not. If we applied the benchmark match rate of 92.2 percent to this group, we would have estimated that 12.9 percent of women (or 89) likely participated in WIC through a Cherokee or

Potawatomi clinic. In other words, of the 143 women in this group who reported that they participated in WIC but did not link to a WIC record, 89 participated through one of the two ITOs that did not provide WIC administrative data to the study. These 89 women would have been misclassified as nonparticipants if we defined WIC participation based on available administrative records.

Following the same logic, the estimated number of Native American women in Group D who would have been misclassified is 125, or 54.5 percent. In Group B, the number of misclassified women would have been 19 (or 6.9 percent) among non-Native Americans and 44 (or 52.6 percent) among Native Americans. In Group C, the number of misclassified women would have been 124 (or 8.7 percent) among non-Native Americans, and 269 (or 45.3 percent) among Native Americans.

To minimize the potential bias, we excluded from the analysis women who (1) likely participated in WIC and (2) were not found in the WIC administrative data provided by the State and seven participating ITOs.[3] Specifically, we excluded women who met the following three criteria: (1) lived relatively close to a Cherokee or Potawatomi clinic (Groups B, C and D); (2) reported participating in WIC on the birth certificate; and (3) did not link to a WIC record. The number of women we excluded using these criteria is 989 (shown in red font in Table C.1) among 31,104 women with known zip codes of residence and known WIC status as reported on the birth certificates.

Another group of women who could potentially have been excluded from the analysis is women who (1) lived relatively close to a Cherokee or Potawatomi clinic, (2) likely participated in WIC through one of these two ITOs, but (3) erroneously reported that they did not participate in WIC on the birth certificate. The number of women who met these criteria, however, was relatively low. For example, in Group D, we estimated that 15 (or 7.8 percent of) non-Native American women who reported that they did not participate in WIC likely participated through a Cherokee or Potawatomi clinic (and we do not have WIC records for them). Among Native Americans in Group D, the estimated number of women was only 3 (or 7.3) percent (see columns 4 and 8 in Table C.1). In order to avoid misclassifying these women as nonparticipants, we would have had to exclude all women who reported that they did not participate in WIC and did not link to a WIC record. For example, among non-Native American women in Group D, we would have had to exclude 174 women in order to avoid potentially misclassifying 15 women; among Native Americans in Group D, we would have had to exclude 40 women to avoid misclassifying 3.

These additional exclusions would have resulted in an unbalanced sample in terms of geographic location. That is, we would have had a sample in which WIC participants in Groups B, C, and D would not have an equivalent comparison group from the same geographic area. If there are systematic (or unobserved) differences among women across the geographic areas that

[3] We cannot simply use reported WIC participation from the birth certificate to classify women as WIC participants or nonparticipants because (1) self-reported participation is not as reliable as participation based on WIC records and (2) our approved analysis plan uses measures of WIC participation that consider both the timing and length of participation (as opposed to a dichotomous measure). Without WIC administrative data, we cannot construct these measures of WIC participation.

are correlated with our outcome measures, then excluding all nonparticipants within a geographic location but including WIC participants would have resulted in an imbalance that could have led to bias. Given that the potential number of misclassified women was relatively low, and there was a risk that the additional exclusions would introduce bias due to an unbalanced sample, we included in the analysis all women who reported not participating in WIC on the birth certificate.

The sample presented in Table C.1 includes women with a known zip code of residence and known WIC participation status from the birth certificate. WIC participation was missing from the birth certificates of 200 women. Of these, 171 were classified as Group A based on their zip codes and were therefore included in the analysis. The remaining 29 women were categorized into Groups B, C, and D. The numbers in these groups were too low for us to estimate reliable WIC participation rates. Therefore, we excluded these 29 women from the analysis.

We also had to account for 418 women who had an invalid zip code for their place of residence and are not included in Table C.1. To be conservative, we treated this group as if they belonged in Groups B, C, or D. Of the 418 women, 48 reported participating in WIC on the birth certificate but did not have a linked administrative WIC record. We excluded these women from the analysis. Finally, we excluded 3 women who were missing both reported WIC participation and zip code of residence. In total, we excluded 1,069 of 31,635 women (3.4 percent) from the analysis.

Given the information available for our sample, no perfect solution would have eliminated the risk of bias completely. However, we believe that our approach minimized the risk of bias and maximized the available sample size, thereby maximizing statistical power and the generalizability of the impact estimates to the Oklahoma WIC-eligible Medicaid population.

Table C.2 summarizes the characteristics of the included and excluded samples. The table indicates a number of differences between the mother–infant dyads included and excluded from the main sample. As might be expected, the mothers excluded from the sample more often had a Native American Indian or Alaskan Native race recorded on the birth certificate (and less often other races or foreign born) and more often lived in a rural area of Oklahoma. They were more often married and more often had a high school diploma or General Equivalency Degree (and less often had other education levels). The differences between the two groups on pregnancy risk factors were mixed. For example, the excluded mothers were more likely to have had a cesarean delivery and a very short (6–month or shorter) inter-pregnancy interval, but less often had a short (6- to 17-month) inter-pregnancy interval. There were also differences between the analysis sample and the excluded mother–infant dyads across the outcome variables from the birth certificate (with higher rates of adverse birth events for some outcomes, but not all).

These differences indicate that results obtained for the main analysis sample will not necessarily generalize to the excluded mother–infant dyads. In robustness checks discussed in Chapter III, we assessed the level of bias that might have resulted from misclassification of WIC participants who enrolled through a Cherokee or Potawatomi agency. We show that our main findings were robust to two sensitivity tests—one that retained all excluded cases and considered them to be nonparticipants and another that retained all excluded cases and considered them to be participants.

Table C.1. WIC participation rates based on self-reported and WIC administrative data, by women's geographic location and race

	Non-Native American				Native American			
	Linked to WIC administrative record			Potentially misclassified as nonparticipants	Linked to WIC administrative record			Potentially misclassified as nonparticipants
	No (1)	Yes (2)	Total (3)	(4)	No (5)	Yes (6)	Total (7)	(8)
Group A: Closest clinic is a State-affiliated LWA or participating ITO clinic and there is no Cherokee or Potawatomi clinic within 10 miles								
WIC from BC:								
No	4,178	952	5,130	n.a.	600	131	731	n.a.
	81.4%	18.6%	100%		82.1%	17.9%	100%	
Yes	1,396	16,601	17,997	n.a.	442	2,523	2,965	n.a.
	7.8%	92.2%	100%		14.9%	85.1%	100%	
Total	5574	17,553	23,127	n.a.	1,042	2,654	3,696	n.a.
	24.1%	75.9%	100%		28.2%	71.8%	100%	
Group B: Closest clinic is a State-affiliated LWA or participating ITO clinic, but there is a Cherokee or Potawatomi clinic within 10 miles								
WIC from BC:								
No	55	11	66	1	17	1	18	2
	83.3%	16.7%	100%	1.9	94.4%	5.6%	100%	12.3%
Yes	*40**	233	273	19	*56**	27	83	44
	14.7%	85.4%	100%	6.9%	*67.5%*	32.5%	100%	52.6%
Total	95	244	339	20	73	28	101	46
	28.0%	72.0%	100%	5.9	72.3%	27.7%	100%	45.5%
Total after exclusion	55	244	299	1	17	28	45	2
	18.4%	81.6%	100%	0.3	37.8%	62.2%	100%	4.4%
Group C: Equal distance to State-affiliated LWA, participating ITO, and Cherokee or Potawatomi clinics								
WIC from BC:								
No	354	66	420	12	144	12	156	16
	84.3%	15.7%	100%	2.9	92.3%	7.7%	100%	10.2%
Yes	*234**	1,187	1,421	124	*357**	236	593	269
	16.5%	83.5%	100%	8.7	*60.2%*	39.8%	100%	45.3%
Total	588	1,253	1,841	136	501	248	749	285
	31.9%	68.1%	100%	7.4%	66.9%	33.1%	100%	38.1%
Total after exclusion	354	1,253	1607	12	144	248	392	16
	22.0%	78.0%	100%	0.7%	36.7%	63.3%	100%	4.1%

	Non-Native American				Native American			
	Linked to WIC administrative record			Potentially misclassified as nonparticipants	Linked to WIC administrative record			Potentially misclassified as nonparticipants
	No (1)	Yes (2)	Total (3)	(4)	No (5)	Yes (6)	Total (7)	(8)
Group D - Closest clinic is a Cherokee or Potawatomi clinic								
WIC from BC:								
No	174	21	195	15	42	5	47	3
	89.2%	10.8%	100%	7.8%	89.4%	10.6%	100%	7.3%
Yes	*143**	547	690	89	*159**	70	229	125
	20.7%	79.3%	100%	12.9%	*69.4%*	30.6%	100%	54.5%
Total	317	568	885	104	201	75	276	128
	35.8%	64.2%	100%	11.8%	72.8%	27.2%	100%	46.4%
Total after exclusion	174	568	742	15	42	75	117	3
	23.5%	76.5%	100%	2.0%	35.9%	64.1%	100%	2.6%

Source: WIC-M II database for Oklahoma prenatal analysis, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 that were linked with a Vital Records birth certificate. Row percentages may not total 100 percent due to rounding.

* Excluded mother-infant dyads.

BC = birth certificate; ITO = Indian Tribal Organization; LWA = local WIC agency; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

n.a. = not applicable.

Table C.2. Comparison of mother–infant dyads included or excluded in the analysis sample (based on whether the mother may have participated in WIC through a Cherokee or Potawatomi clinic)

Characteristic	Included dyads	Excluded dyads
Mother's characteristics		
Age		
17 years or younger	5.55	4.86
18–19 years	12.62	14.49
20–34 years	76.28	75.70
35 years or older	5.55	4.95
Race/ethnicity		
Hispanic	18.35	7.76††
Non-Hispanic white	53.41	32.43
Non-Hispanic black	10.76	2.80
Non-Hispanic American Indian Alaskan Native	10.41	50.00
Non-Hispanic Asian Pacific Islander	1.95	0.75
Non-Hispanic other race	0.25	0.09
Non-Hispanic multiracial	4.86	6.17
Foreign-born	15.04	5.14**
Married	39.74	43.74**
Education		
Less than high school	31.75	29.07††
High school graduate or GED	35.49	42.34
Some college, no degree	28.19	25.23
College degree	4.31	3.36
Unknown	0.26	0.00
Rural residence	42.18	83.93**
Prenatal care from public clinic	9.66	9.72
Family income less than 100 percent of FPL	80.61	80.09
Mean household Income (percentage of FPL)	52.42	51.83
TANF enrollment (mother)	19.49	20.65
Aged, blind, and/or disabled Medicaid enrollment (mother)	0.46	0.47
Newborn's characteristics		
Infant's gender is male	51.23	50.84
Pregnancy risk factors		
BMI before pregnancy		
Less than 18.5 (underweight)	5.23	4.21††
18.5 to 24.9 (normal)	42.40	39.63
25.0 to 29.9 (overweight)	24.28	24.11
30.0 to 40.4 (obese)	21.24	25.42
40.5 or more (extremely obese)	5.55	5.98
Unknown	1.29	0.65
Smoked three months before pregnancy	16.20	13.93*
Number of cigarettes per day before pregnancy	1.47	1.88*

Characteristic	Included dyads	Excluded dyads
Previous cesarean delivery	14.73	17.20*
Previous preterm birth	2.19	1.87
Previous other poor birth outcomes	1.39	1.31
Pre-pregnancy diabetes	0.80	1.21
Pre-pregnancy hypertension	1.42	0.84
Pregnancy history		
Inter-pregnancy interval		
First birth	34.10	34.77††
18 months or more	34.49	37.20
Short (6 to 17 months)	17.20	16.92
Very short (fewer than 6 months)	8.57	8.88
Unknown	5.64	2.24
Number of previous live births (mean)	1.25	1.19
Any previous terminations	20.28	16.37**
Primary outcomes		
Preterm birth (percentage fewer than37 weeks)	10.15	11.87
Low birthweight (percentage fewer than 2,500g)	7.51	6.36
Very low birthweight (percentage fewer than1,500g)	1.24	1.31
Small-for-gestational age (%)	10.66	8.04**
Neonatal mortality (deaths per 1,000)	3.68	4.67
Breastfeeding at discharge (%)	66.86	48.20**
Had lower than recommended weight gain during pregnancy (%)	21.63	20.89
Had higher than recommended weight gain during pregnancy (%)	41.18	43.91
Sample size	30,682	1,070
Percentage with mother's record(s) in Medicaid files	97.53	95.79**
Percentage with infant's record(s) in Medicaid files	88.99	90.37

Source: WIC-Medicaid II Database for Oklahoma prenatal analysis, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 that were linked with a Vital Records birth certificate.

Each row contains the proportions or mean of a characteristic for mother–infant dyads included in the main sample, or excluded because the child might have participated at a Cherokee or Potawatomi WIC clinic (by age cohort).

The table presents the percentage of observations for binary and categorical variables, and it presents means for continuous variables. Variables are defined in Chapter III, Table III.4. Asterisks denote statistically significant differences between WIC participants and nonparticipants from Student's t-tests for dichotomous and continuous variables (* $p < 0.05$; ** $p < 0.01$) and daggers denote statistically significant chi-squared tests for categorical variables († $p < 0.05$; †† $p < 0.01$). Percentages across categories might not sum to 100 percent because of rounding and missing data.

BMI = body mass index; FPL = Federal poverty level; GED = General Equivalency Degree; TANF = Temporary Assistance for Needy Families; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

B. Children's analysis

We also based our approach for dealing with missing WIC administrative data for the children's analysis on geographic location. However, we could not use the approach used for the prenatal analysis because we did not have information on the birth certificate about a child's participation in WIC. Mother's participation during pregnancy is a strong predictor of the child's participation. However, for the children's sample, we did not have self-reported WIC participation of the mothers available on the birth certificates because the sample of children were born from 2005 to 2009 and Oklahoma did not implement the revised birth certificate until 2010. In addition, for children, we were assessing WIC participation over a longer time period and had to take mobility into account.

Step 1. Categorize children according to distance to nearest Cherokee or Potawatomi WIC clinic

Following logic similar to that used in the prenatal analysis, we categorized children based on the distance between their residences and the nearest Cherokee or Potawatomi clinic. For each child, we had the zip code of residence at the time of birth (as recorded on the birth certificate), as well as the zip code of residence at the time of the most recent Medicaid recertification (as reported in the Medicaid files). [4] For children who did not move during our study period—that is, children who had the same zip codes on the birth certificates and the most recent Medicaid recertification—we defined distance to the nearest clinic the same way as for the prenatal sample. Children who moved but had both zip codes fall within the same distance category (Groups A, B, C, or D, as described in the preceding discussion of the prenatal analysis) were classified into Groups A, B, C, or D using the definitions described for the prenatal analysis. For children who moved and switched distance categories, we assessed whether, for either of the zip codes, there was a Cherokee or Potawatomi clinic within 10 miles.

Specifically, we organized children into the following groups based on their zip codes of residence:

Group A: For both zip codes, the closest clinic is a State-affiliated LWA or participating ITO clinic, and no Cherokee or Potawatomi clinic is within 10 miles of the zip code of residence

Group B: For both zip codes, the closest clinic is a State-affiliated LWA or participating ITO clinic, but a Cherokee or Potawatomi clinic is within 10 miles of the zip code of residence

Group C: For both zip codes, there is equal distance between the zip code of residence and State-affiliated LWA, participating ITO, or Cherokee or Potawatomi clinics

Group D: For both zip codes, the closest clinic is a Cherokee or Potawatomi clinic

[4] From the Medicaid files, we have only the address that was reported at the most recent enrollment date. The current address overwrote all previous addresses.

Group E: For one of the zip codes, the closest clinic is a State-affiliated LWA or participating ITO clinic and no Cherokee or Potawatomi clinic is within 10 miles

Group F: All other combination of zip codes

We created the last two categories (E and F) because whether we have any WIC administrative records for a child who moved depends on whether the child ever lived in an area that is relatively far from a Cherokee or Potawatomi clinic but close to a State-affiliated LWA or participating ITO clinic.

The sample contained 1,526 children (less than 2 percent of the total sample) who had only one valid zip code reported. We grouped these children into Groups A, B, C, and D based on the one valid zip code.

Step 2. Compare WIC participation rates across the geographic groups against a benchmark participation rate

For the children's analysis sample, we defined the benchmark WIC participation rate as the rate among children in Group A—those with both zip codes being closest to a State-affiliated LWA or participating ITO clinic and with no Cherokee or Potawatomi clinic within 10 miles. The observed rate of WIC participation among these children is most likely based on complete WIC administrative records. Assuming that this rate also applies to children living in other areas of Oklahoma, we compared the benchmark rate with the participation rate among children in Groups B, C, D, and E, separately for children with non-Native American parents and children with at least one parent identifying as Native American. A substantially lower rate of WIC participation among the non-benchmark groups is most likely due to missing data from the Cherokee and Potawatomi WIC agencies.

The top panel of Table C.3 presents rates of WIC participation for children with two valid zip codes in Groups A–E. The benchmark rate for both children with non-Native American and Native American parents is about 80 percent (80.3 percent among children of non-Native American parents and 79.6 percent among children with Native American parents). This means that about 80 percent of children in Group A participated in WIC anytime from ages 1 to 4.

As expected, WIC participation rates were lower in all other groups. Among children with non-Native American parents, participation rates ranged from 69.4 to 75.0 percent across Groups B, C, D, and F. The rate was 77.7 among children in Group E, which is quite close to the benchmark rate of 80 percent. This is not surprising because children in Group E lived close to a State-affiliated LWA or participating ITO clinic at some time during our study period. The rates of WIC participation among children with Native American parents in Groups B, C, D, E, and F were further from the benchmark than what we observed for children with non-Native American parents (45.6 to 73.4 percent). Again, the rate in Group E was the one closest to the benchmark.

The bottom panel of Table C.3 shows rates of WIC participation for children with only one valid zip code. In Group A, the WIC participation rate was 80.1 percent among children with non-Native American parents and 77.2 percent among children with Native American parents—both very close to the benchmark rate we observed among children in Group A with

two valid zip codes. Among children with non-Native American parents, the rates of WIC participation were close to the benchmark in Groups B and C. The only group with a substantially lower rate was Group D. Among children with Native American parents, the rate of WIC participation was substantially lower than the benchmark in Groups C and D; however, these rates were based on relatively small sample sizes.

Step 3. Recommendation for handling missing WIC records from Cherokee Nation and Citizen Potawatomi Nation WIC agencies

Columns 4 and 8 in Table C.3 present the estimated number and percentage of children in each distance category who would have been misclassified for a binary measure of ever participating in WIC. For example, if we applied the benchmark rate of 80 percent to children with non-Native American parents in Group B, we estimate that 10.9 percent (or 55) children in this group would have been misclassified. The pattern of WIC participation rates among children across groups was consistent with the theory that children enroll in WIC through the closest clinic. There was also evidence suggesting that children with Native American parents were more likely to enroll through a tribal agency. Thus, excluding children from the analysis based on their geographic location and parents' race was a reasonable approach to dealing with the issue of missing WIC data for the Cherokee and Potawatomi WIC agencies.

Among children with two valid zip codes, we excluded from the analysis children in Groups B, C, D, and F because these groups had considerably lower match rates to WIC records relative to the benchmark.[5] We excluded all children in a group with a low match rate (as opposed to excluding only those who did not match to a WIC record) to maintain balance in the final analysis sample in terms of the geographic locations of participants and nonparticipants. Among children with only one valid zip code, we excluded from the analysis (1) children in Groups C and D with Native American parents and (2) children in Group D with non-Native American parents.

Based on these decision rules, we excluded from the analysis 6,311 of 79,266 children (8 percent) with at least one known zip code of residence (highlighted in red in Table C.3). An additional 232 children lacked a valid zip code. About 70 percent of these children linked to a WIC record. Given the relatively low match rate, we excluded these children from the analysis. It is worth noting that many of these children would have been excluded from the sample *anyway* because they were identified as Native Americans in the Medicaid files, and were thus excluded from the sample. As discussed in Chapter II and elsewhere, the Oklahoma Medicaid agency did not provide Medicaid claims for Native Americans.

[5] The rate of WIC participation based on a binary measure of WIC among children in Group E is very close to the benchmark. This is a relatively large group. We therefore recommend keeping them in the main analysis. For the analysis of dose-response effect, which requires that we have a complete history of WIC participation for each child enrolled in WIC, we could either exclude these children or assume that they were continuously enrolled since birth until the latest available WIC record.

Excluding children from the analysis based on their geographic proximity to a Cherokee or Potawatomi WIC clinic is more likely to provide internally valid estimates relative to the alternative of keeping all children in the sample. The downside of this approach is that results might not generalize to all children on Medicaid if children excluded from the sample are very different from those included in the sample. We believe this is a reasonable trade-off considering that we lose only about 8 percent of the sample.

For completeness and transparency, Table C.4 compares the background characteristics of included and excluded children. (The table does not include children identified as Native Americans in the Medicaid data because these observations were excluded from the sample for other reasons, as described in Chapter II). The table shows that, as in the prenatal analysis, excluded observations were more often from rural areas of the State. Otherwise, observed differences between the two groups were not large (although some were statistically significant due to the large sample sizes). The differences in Table C.4 indicate that results obtained from the main analysis sample might not generalize to the excluded children.

Table C.3. WIC participation rates based on WIC administrative data, by children's geographic location and parents' race; children who did not move from birth to 2010

	Non-Native American parents				Native American parents			
	Linked to WIC administrative record			Potentially misclassified as nonparticipants	Linked to WIC administrative record			Potentially misclassified as nonparticipants
	No (1)	Yes (2)	Total (3)	(4)	No (5)	Yes (6)	Total (7)	(8)
Children with two valid zip codes								
Group A: For both zip codes, the closest clinic is a State-affiliated LWA or participating ITO clinic and no Cherokee or Potawatomi clinic is within 10 miles	12,132	49,505	61,637	n.a.	1,019	3,987	5,006	n.a.
	19.7%	80.3%	100%		20.4%	79.6%	100%	
Group B: For both zip codes, the closest clinic is a State-affiliated LWA or participating ITO clinic but a Cherokee or Potawatomi clinic is within 10 miles	153*	347*	500*	55	23*	37*	60*	11
	30.6%	69.4%	100%	10.9%	38.3%	61.7%	100%	18.0%
Group C: For both zip codes, there is equal distance to a State-affiliated LWA, participating ITO, and Cherokee or Potawatomi clinics	741*	2,227*	2,968*	157	144*	246*	390*	65
	25.0%	75.0%	100%	5.3%	36.9%	63.1%	100%	16.6%
Group D: For both zip codes, the closest clinic is a Cherokee or Potawatomi clinic	432*	1,023*	1,455*	146	106*	89*	195*	66
	29.7%	70.3%	100%	10.0%	54.4%	45.6%	100%	34.0%
Group E: For one of the zip codes, the closest clinic is a State-affiliated LWA or participating ITO clinic and no Cherokee or Potawatomi clinic is within 10 miles	1,005	3,491	4,496	120	112	309	421	26
	22.4%	77.7%	100%	2.7%	26.6%	73.4%	100%	6.24%
Group F: All other combinations of zip codes	152*	363*	515*	51	28*	29*	57*	16
	29.5%	70.5%	100%	9.8%	49.1%	50.9%	100%	28.8%

	Non-Native American parents				Native American parents			
	Linked to WIC administrative record			Potentially misclassified as nonparticipants	Linked to WIC administrative record			Potentially misclassified as nonparticipants
	No (1)	Yes (2)	Total (3)	(4)	No (5)	Yes (6)	Total (7)	(8)
Children with one valid zip code								
Group A: Closest clinic is a State-affiliated LWA or participating ITO clinic and no Cherokee or Potawatomi clinic is within 10 miles	232	933	1,165	n.a.	33	112	145	n.a.
	19.9%	80.1%	100%		22.8%	77.2%	100%	
Group B: Closest clinic is a State-affiliated LWA or participating ITO clinic but there is a Cherokee or Potawatomi clinic within 10 miles	7	30	37	n.a.	0	0	0	0
	18.9%	81.1%	100%					
Group C: There is equal distance to State-affiliated LWA, participating ITO, and Cherokee or Potawatomi clinics	25	83	108	4	14*	15*	29*	8
	23.2%	76.9%	100%	3.5	48.3%	51.7%	100%	27.9%
Group D: Closest clinic is a Cherokee or Potawatomi clinic	14*	24*	38*	7	2*	2*	4*	1
	36.8%	63.2%	100%	17.1	50.0%	50.0%	100%	29.6%

Source: WIC-Medicaid II Database for Oklahoma children's analysis, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Oklahoma continuously enrolled from January to December 2010 who were linked with a Vital Records birth certificate.

* Excluded children.

ITO = Indian Tribal Organization; LWA = local WIC agency; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

n.a. = not applicable.

Table C.4. Comparison of children included or excluded in the analysis sample (based on whether the child may have participated in WIC through a Cherokee or Potawatomi WIC clinic)

	Cohort of 1-year-olds		Cohort of 2-year-olds		Cohort of 3-year-olds		Cohort of 4-year-olds	
	Included children	Excluded children	Included children	Excluded children	Included children	Excluded children	Included children	Excluded children
Mother's characteristics								
Age								
17 years or younger	5.68	4.33††	6.16	6.09††	6.46	5.24††	6.31	7.35
18–19 years	12.83	12.39	12.97	11.50	12.72	13.13	12.57	12.09
20–34 years	75.80	75.21	75.12	74.56	75.30	73.82	75.55	74.51
35 years or older	5.69	8.06	5.75	7.85	5.51	7.81	5.58	6.05
Race/ethnicity								
Hispanic	21.69	17.99††	20.88	17.05††	21.30	18.66††	20.45	17.65††
Non-Hispanic white	58.10	66.06	58.88	67.93	58.31	67.83	58.52	67.81
Non-Hispanic black	14.67	8.24	14.97	9.00	15.34	8.35	16.03	8.33
Non-Hispanic American Indian Alaskan Native	3.10	4.63	3.39	4.53	3.26	3.49	3.02	4.49
Non-Hispanic Asian Pacific Islander	1.66	1.93	1.65	1.29	1.36	1.52	1.44	0.98
Multiple races, other race, or unknown	0.78	1.14	0.23	0.20	0.43	0.15	0.54	0.74
Married	40.80	44.77**	41.56	46.41**	41.89	45.60**	43.01	41.75
Education								
Less than high school	32.63	32.55	33.13	31.06	34.93	33.84	34.92	34.48
High school graduate or GED	42.81	41.58	44.00	45.74	43.68	43.93	43.39	42.65
Some college, no degree	18.91	19.31	17.58	17.52	16.23	17.07	16.76	17.32
College degree	5.16	5.66	4.69	4.74	4.49	4.02	4.36	4.74
Unknown	0.49	0.90	0.61	0.95	0.67	1.14	0.57	0.82
Smoked during pregnancy	19.85	22.08*	21.69	22.53	22.32	22.46	22.23	23.94
Any previous live births	63.22	65.22	64.01	63.80	64.94	65.02	64.05	61.44
Short inter-pregnancy interval	22.50	22.14	23.69	21.99	22.78	22.46	21.92	20.02
Child's characteristics								
Gender is male	51.56	50.48	50.93	51.56	51.58	50.61	51.66	49.84
Gestational age (in weeks)	38.44	38.32*	38.41	38.37	38.53	38.43	38.50	38.48

	Cohort of 1-year-olds		Cohort of 2-year-olds		Cohort of 3-year-olds		Cohort of 4-year-olds	
	Included children	Excluded children	Included children	Excluded children	Included children	Excluded children	Included children	Excluded children
Preterm birth (fewer than 37 weeks)	11.49	10.14	11.20	11.19	10.80	9.13	10.99	10.89
Very preterm birth (32 weeks or fewer)	2.23	1.81	2.20	1.76	2.21	1.45	2.01	2.05
Birthweight (in grams)	3,210	3,195	3,201	3,193	3,253	3,203**	3,224	3,216
Low birthweight (fewer than 2500g)	9.77	8.26*	9.24	9.68	9.09	6.69**	9.00	8.33
Very low birthweight (fewer than 1,500g)	1.50	1.15	1.43	1.22	1.22	0.84	1.27	0.65*
Multiple birth	3.04	2.65	2.99	4.47**	2.90	1.97	2.79	2.45
Rural residence	36.26	69.55**	36.95	72.19**	36.24	69.65**	36.16	70.42**
Mean household income (as percentage of the Federal poverty level)	56.60	53.74*	58.21	56.22	60.28	57.20*	59.36	57.81
Family income 100 percent of the Federal poverty level or less	80.71	79.06	79.71	78.69	79.19	78.45	79.13	78.59
TANF enrollment	99.05	99.22	98.55	98.04	98.21	97.80	97.97	97.30
Aged, blind, and/or disabled Medicaid enrollment category	0.54	0.18*	0.61	0.68	0.59	0.53	0.76	0.41
Child welfare Medicaid enrollment category	3.34	1.14**	3.57	1.89**	3.41	1.82**	3.47	1.14**
Sample size	**17,291**	**1,662**	**15,974**	**1,478**	**15,780**	**1,318**	**14,252**	**1,224**

Source: WIC-Medicaid II Database for Oklahoma children's analysis, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Oklahoma continuously enrolled from January to December 2010 who were linked with a Vital Records birth certificate.

Each row contains the proportions or mean of a characteristic for children included in the main sample, or excluded because a child might have participated at a Cherokee or Potawatomi WIC clinic (by age cohort).

The asterisks denote a statistically significant difference from Student's t-tests for dichotomous and continuous variables (* $p < 0.05$; ** $p < 0.01$) and daggers denote statistically significant chi-squared tests for categorical variables († $p < 0.05$; †† $p < 0.01$). Percentages across categories might not sum to 100 percent because of rounding and missing data.

GED = General Equivalency Degree; TANF = Temporary Assistance for Needy Families; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

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APPENDIX D

SUCCESS OF INVERSE PROBABILITY WEIGHTING AT CREATING A SIMILAR COMPARISON GROUP

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As described in Chapters III and IV, the study team used inverse probability weighting (IPW) to control for differences in measured characteristics of WIC participants and nonparticipants. This appendix reports on the success of IPW in creating well-matched comparison groups. For IPW to perform well, the two groups should demonstrate some degree of balance before IPW. That is, a substantial subset of nonparticipants should exist that possesses characteristics similar to those of WIC participants—though the two groups as a whole can differ on average. For example, although the groups of WIC participants and nonparticipants might have different proportions of teenage mothers, concern would be warranted if all or nearly all teenage mothers were WIC participants, leaving very few or no teenage mothers in the group of nonparticipants. After creating a comparison group with IPW, no meaningful differences between the two groups should remain. The team assessed balance between the WIC participants and nonparticipants in several ways. As described in the following sections, IPW was successful in improving the balance between the WIC participants and nonparticipants in both analyses.

A. Success of IPW in the prenatal analysis

Comparing the estimated probabilities of WIC participation—the propensity scores—can generate a summary measure of the similarity of WIC participants and nonparticipants. Figure D.1 presents the distribution of the propensity scores for the prenatal analysis sample before and after IPW was implemented.[6] In Figure D.1 (for both States), Panel A shows that WIC participants and nonparticipants did not demonstrate balance before IPW—the propensity scores for nonparticipants (bars facing downward) are lower, on average, than the propensity scores for participants (bars facing upward). Moreover, the distribution skews to the right for WIC participants. However, the distributions of the two groups largely overlap before IPW, and few observations in either group have very low or very high propensity scores. These differences disappear after the application of IPW (Panel B), and the propensity score distribution for nonparticipants mirrors the distribution for participants (in both States). The quantile-quantile plot in Panel C of Figure D.1 confirms this. Table D.1 presents summary statistics on these distributions to quantify the patterns observed in the figures. The mean propensity score for the two groups is virtually identical after IPW in both States (difference = 0.0, and the ratio of variances is close to 1.0), and after IPW there are no large differences in the mean of the propensity scores by quantiles (although samples are large enough to detect very small differences within the quantiles with Student's t-tests).

A second analysis, presented in Table D.2, examines the improvement in balance achieved between the WIC participants and nonparticipants on individual characteristics included as predictors in the propensity score model. There are some differences between the WIC participants and nonparticipants before IPW. For example, the table shows that in Missouri 9 percent of prenatal WIC participants and 6 percent of nonparticipants were Hispanic. Because the sample size is large, there is sufficient statistical power to detect this small difference using Student's t-test: the difference between 9 and 6 percent is statistically significant (p-value = 0.00). A better metric of similarity is the standardized bias (SB)—a measure of the number of

[6] Note that there is a copy of the tables and figures for each State; in this case Figure D.1 is labeled Figure D.MO.1 and Figure D.OK.1 for Missouri and Oklahoma, respectively. The appendices to this report use this same naming convention throughout.

standard deviations by which groups differ.[7] The difference in the proportion of mothers who were Hispanic is 10.8 percent of one standard deviation before IPW (column 6 in Table D.MO.2). An absolute value of the standardized bias (ASB) greater than 25 percent of a standard deviation is commonly considered meaningfully large.[8] Given the large number of covariates examined, Figure D.2 shows the SBs from column 6 in Table D.2. The SBs in Missouri were roughly centered on zero before IPW and ranged from −18.9 to +42.1 percent of a standard deviation and the ASB was 6.7 percent of a standard deviation, on average. In Oklahoma, the SBs ranged from −13.9 to +21.5 percent of a standard deviation and the ASB was 6.4 percent of a standard deviation, on average. Notably, the ASB was less than the rule of thumb—25 percent of a standard deviation—for all variables in Oklahoma and all but two variables in Missouri. In Table D.3, two multivariate tests (per State) that assess balance across all covariates rejected the null hypothesis that WIC participants and nonparticipants were similar before IPW.

The analysis demonstrates the improvements in balance achieved through IPW between the WIC participants and nonparticipants. After IPW, there were no meaningfully large differences on the individual characteristics. Continuing with the preceding example, 9 percent of matched nonparticipants were Hispanic (the same rate as the WIC participants) after matching, and the ASB for the proportion of women in Missouri who were Hispanic fell by 81 percent (from SB = 10.8 percent of a standard deviation before IPW to SB = −2.0 percent after IPW). This result is not atypical—the ASB fell considerably for most measures, as intended. Figure D.2 (and column 7 in Table D.2) show the SBs are much more tightly centered on zero after IPW (in both States). Table D.3 confirms this, showing the mean ASB across covariates is far below the 25 percent rule of thumb (the largest ASBs after IPW were 3.6 percent and 2.6 percent in Missouri and Oklahoma, respectively). Furthermore, two multivariate tests failed to reject the null hypothesis that the WIC participants and nonparticipants were similar after IPW (*p*-value equal to or greater than 0.10 for both tests in both States).

A detailed analysis showed that the WIC participants and nonparticipants were balanced on gestational age after IPW. Furthermore, the primary results were qualitatively similar if the associations between WIC participation and the matched nonparticipants are regression-adjusted with a full array of gestational-age dummy variables. This indicates that any residual differences in gestational age are small (unimportant for explaining the main findings).

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[7] See Imbens and Wooldridge (2009, p. 24) for criticisms of Student's t-test. The SB statistic compares means of covariates (X) between WIC participants (P) and nonparticipants (N), standardized by the pooled standard deviation of the participants and nonparticipants before IPW. For the standardized difference before matching, the difference is computed between the sample means in the full sample of participants and nonparticipants. The SB after matching is the difference between the sample means in the participants and matched comparison group.

$$SB\left(before\ IPW\right)=\frac{\overline{X}_P-\overline{X}_{N,\,before\ IPW}}{\sqrt{\left(V\left(X_P\right)+V\left(X_{N,\,before\ IPW}\right)\right)/2}}*100\%\ ;$$

$$SB\left(after\ IPW\right)=\frac{\overline{X}_P-\overline{X}_{N,\,after\ IPW}}{\sqrt{\left(V\left(X_P\right)+V\left(X_{N,\,before\ IPW}\right)\right)/2}}*100\%$$

[8] For instance, the standard used by the U.S. Department of Education's What Works Clearinghouse systematic evidence review for considering groups to be equivalent is a standardized difference less than 0.25 standard deviations (What Works Clearinghouse 2010).

The tables and figures in this appendix focus on the full sample of observations and the improvements in balance resulting from IPW when the propensity score model included gestational age as a matching variable. However, as noted in the text, not all mother–infant dyads were included for all outcome variables. For example, outcome measures from the Medicaid claims data did not include Native Americans in Oklahoma, and the Medicaid cost outcome measure did not include Medicaid beneficiaries in Missouri enrolled in managed care. Also, one specification (for first trimester WIC participation) did not include gestational age as a matching variable. The tables and figures in this appendix were reproduced for various sample definitions and matching variables. IPW performed similarly to the results presented in this appendix across all specifications examined.

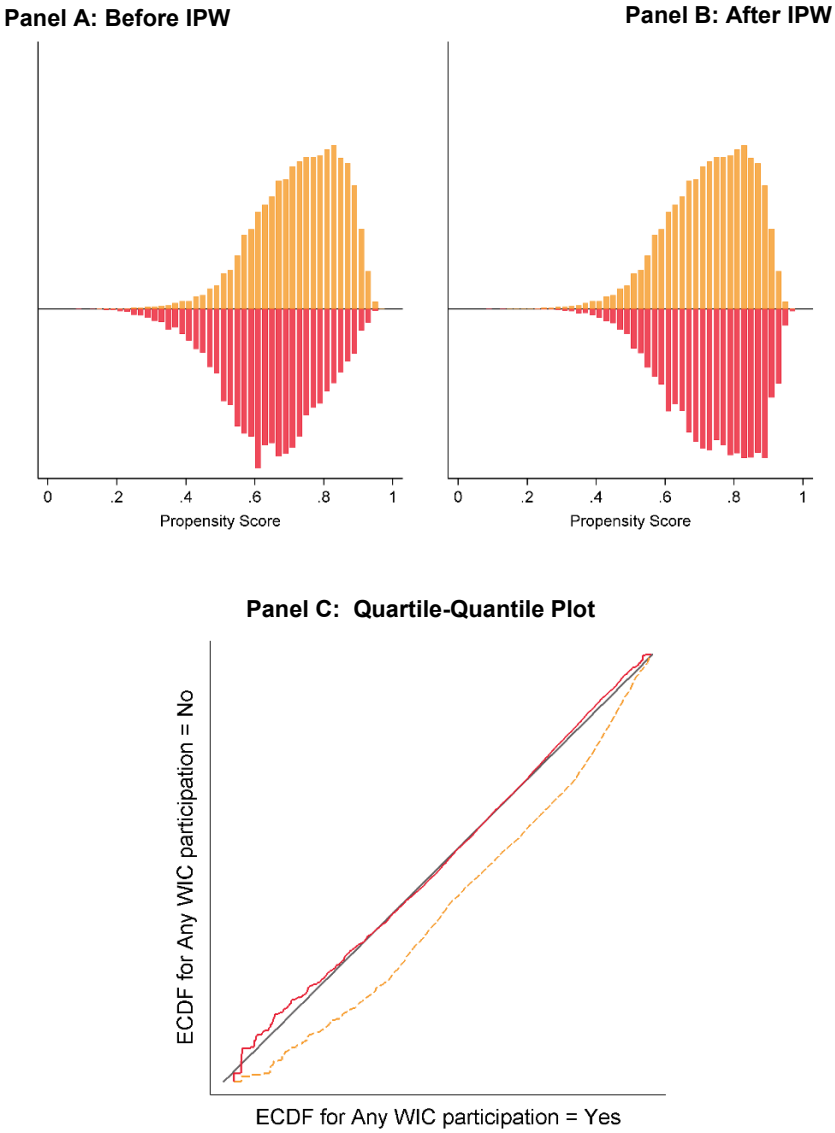
B. Success of IPW in the children's analysis

IPW also improved the similarity of WIC participants and nonparticipants for the children's analysis. Figure D.3 presents the distribution of the propensity scores for the children's analysis sample before and after implementing IPW, with one set of graphs for each age cohort (separately for each State). For all of the age cohorts, WIC participants and nonparticipants do not demonstrate balance before IPW—the propensity scores for nonparticipants (bars facing downward) are lower, on average, than the propensity scores for participants (bars facing upward). Moreover, the distribution is bimodal, and more children in the group of WIC participants had high propensity scores. However, the distributions of the two groups largely overlap before IPW, indicating that the pool of potential comparison group members is likely adequately sized. These differences are removed after application of IPW (the histogram on the right in each panel), and the propensity score distribution for nonparticipants mirrors the distribution for participants. This figure demonstrates how IPW works—the children with high propensity scores receive relatively more weight, increasing the relative size of the mode on the right. Table D.4 presents summary statistics on these distributions, to quantify the patterns observed in the figures. The mean propensity score for the WIC participants and nonparticipants is similar after IPW (difference = 0.00, *p*-value is equal to or greater than 0.10 for all age 4 cohorts in both States), and after IPW there are no large differences in the means of the propensity scores by quantiles (although samples are large enough to detect small differences within the quantiles).

A second analysis, presented in Table D.5, examines the balance between the WIC participants and nonparticipants on individual characteristics included as predictors in the propensity score model before IPW matching; it also compares the two groups after IPW. There are some differences between the WIC participants and nonparticipants before IPW. For example, in the 1-year-old age cohort in Missouri, 39 percent of child WIC participants were from a rural zip code, but only 27 percent of nonparticipants were from a rural zip code, an SB of 25.1 percent of one standard deviation. (This was the only difference over the rule of thumb—25 percent of a standard deviation—for that age cohort.) The ASB was, on average, 4.8 to 6.3 percent of a standard deviation (depending on the age cohort and State). For all four cohorts in both States, the two multivariate tests that assess balance across all covariates rejected the null hypothesis that WIC participants and nonparticipants were similar before IPW (Table D.6).

The analysis in Tables D.5 and D.6 demonstrates that these differences between the WIC participants and nonparticipants diminished greatly after IPW. After IPW, there were no meaningfully large differences on the individual characteristics. Continuing the example from above, the ASB for the proportion of children from a rural zip code in Missouri fell by 98 percent (from SB = 25.1 percent before IPW to SB = 0.5 percent after IPW). Table D.5 reveals the success of IPW at eliminating the largest SBs on the mother and child characteristics before IPW—the SBs are much more tightly centered on zero after IPW (in both States). Table D.6, which shows the mean ASB across covariates is considerably smaller after IPW for the four cohorts in each State, confirms this. Furthermore, two multivariate tests fail to reject the null hypothesis that the WIC participants and nonparticipants are similar after IPW (*p*-value equal to or greater than 0.10 for both tests for all four cohorts in each State).

Figure D.MO.1. Comparison of the distribution of propensity scores for WIC participants and nonparticipants in the prenatal analysis, before and after IPW



Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

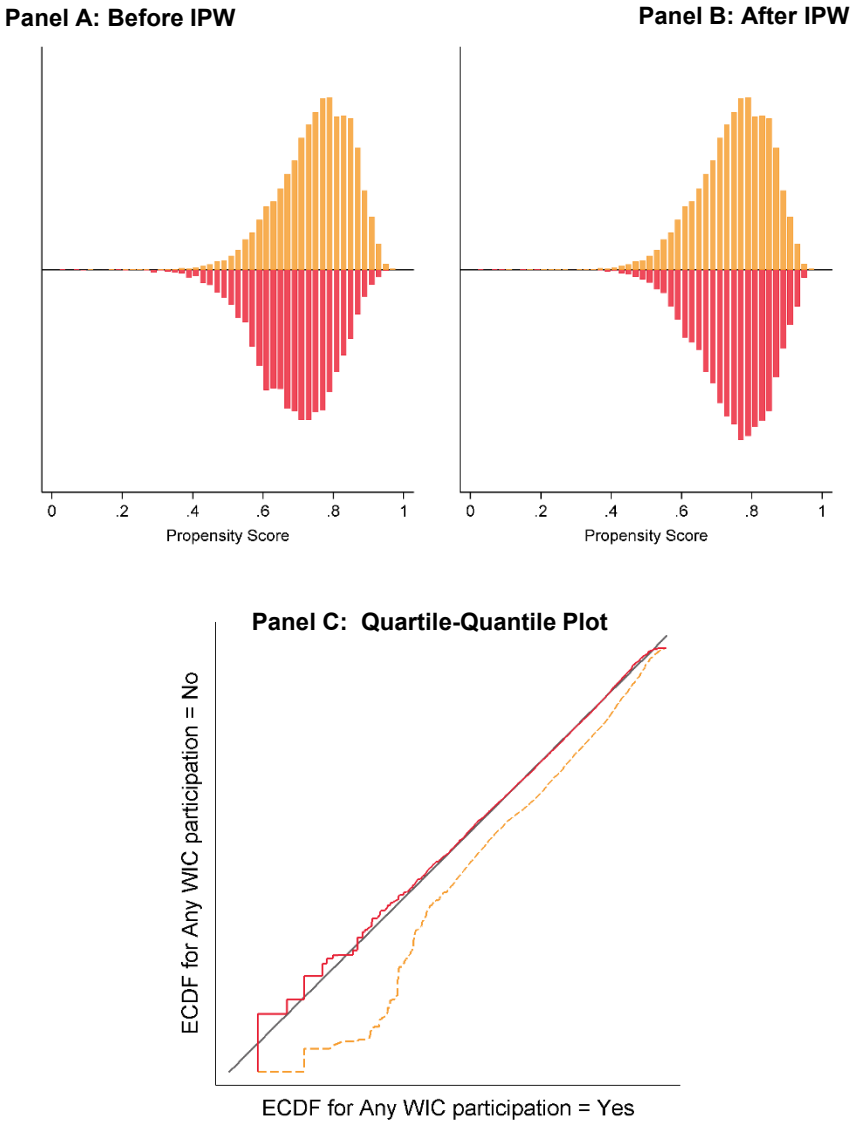
Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate.

Panel A is a histogram with the distribution of the propensity scores without IPW, and Panel B is a histogram of the propensity scores with IPW. WIC participants are presented in the top part of each histogram (bars facing upward) and nonparticipants are presented in the bottom part (bars facing downward) of each histogram. Panel C plots the quantiles of the ECDF of propensity scores for the WIC participants (horizontal axis) against the quantiles of the ECDF for the nonparticipants (vertical axis). The red dotted line is before IPW and the blue line is after applying IPW. A perfectly matched sample would lead to the quantile-quantile plot appearing on the 45-degree line.

In this figure, the propensity score model included gestational age as a matching variable and the figure includes all observations. Table D.MO.1 provides summary statistics for these distributions.

ECDF = empirical cumulative distribution function; IPW = inverse probability weighting; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Figure D.OK.1. Comparison of the distribution of propensity scores for WIC participants and nonparticipants in the prenatal analysis, before and after IPW



Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate.

Panel A is a histogram with the distribution of the propensity scores without IPW, and Panel B is a histogram of the propensity scores with IPW. WIC participants are presented in the top part of each histogram (bars facing upward) and nonparticipants are presented in the bottom part (bars facing downward) of each histogram. Panel C plots the quantiles of the ECDF of propensity scores for the WIC participants (horizontal axis) against the quantiles of the ECDF for the nonparticipants (vertical axis). The red dotted line is before IPW and the blue line is after applying IPW. A perfectly matched sample would lead to the quantile-quantile plot appearing on the 45-degree line.

In this figure, the propensity score model included gestational age as a matching variable and the figure includes all observations. Table D.OK.1 provides summary statistics for these distributions.

ECDF = empirical cumulative distribution function; IPW = inverse probability weighting; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table D.MO.1. Diagnostic tests to assess the quality of the balance of the propensity score distributions for WIC participants and nonparticipants in the prenatal analysis, before and after inverse probability weighting

	Mean of propensity score				Student's T-test				Ratio of variances	
	Participants		Nonparticipants		Difference		*p*-value		(Var_P/Var_N)	
	Before IPW	After IPW	Before IPW	After IPW	Before IPW	After IPW	Before IPW	After IPW	Before IPW	After IPW
Whole sample	0.73	0.73	0.64	0.74	0.09	0.00	0.00	0.00	0.79	0.93
Quantile 1	0.56	0.56	0.46	0.56	0.10	0.00	0.00	0.06	0.89	1.05
Quantile 2	0.70	0.70	0.60	0.70	0.10	0.00	0.00	0.12	1.06	0.98
Quantile 3	0.79	0.79	0.70	0.79	0.09	-0.01	0.00	0.00	0.84	0.87
Quantile 4	0.87	0.87	0.82	0.88	0.06	-0.01	0.00	0.00	0.34	0.97
Quantiles 1 to 4 (joint F-test)							0.00	0.00		

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate.

This table presents summary statistics on the distribution of the propensity scores for WIC participants and nonparticipants, before and after IPW. These distributions are presented graphically in Figure D.MO.1. The propensity score model included gestational age and the full set of covariates shown in Chapter III, Table III.4.

IPW = inverse probability weighting; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table D.OK.1. Diagnostic tests to assess the quality of the balance of the propensity score distributions for WIC participants and nonparticipants in the prenatal analysis, before and after inverse probability weighting

	Mean of propensity score				Student's T-test				Ratio of variances	
	Participants		Nonparticipants		Difference		*p*-value		(Var_P/Var_N)	
	Before IPW	After IPW	Before IPW	After IPW	Before IPW	After IPW	Before IPW	After IPW	Before IPW	After IPW
Whole sample	0.75	0.75	0.69	0.75	0.06	0.00	0.00	0.98	0.81	1.00
Quantile 1	0.61	0.61	0.54	0.61	0.07	0.00	0.00	0.28	0.73	1.07
Quantile 2	0.73	0.73	0.66	0.73	0.07	0.00	0.00	0.00	0.82	1.00
Quantile 3	0.79	0.79	0.74	0.79	0.06	0.00	0.00	0.00	0.82	0.98
Quantile 4	0.87	0.87	0.82	0.87	0.04	0.00	0.00	0.02	0.56	0.87
Quantiles 1 to 4 (joint F-test)							0.00	0.01		

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate.

This table presents summary statistics on the distribution of the propensity scores for WIC participants and nonparticipants, before and after IPW. These distributions are presented graphically in Figure D.OK.1. The propensity score model included gestational age and the full set of covariates shown in Chapter III, Table III.4.

IPW = inverse probability weighting; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table D.MO.2. Comparisons of mother and infant characteristics for WIC participants and nonparticipants in the prenatal analysis, before and after inverse probability weighting

		Mean		Student's T-test			Standardized bias	
Variable	Contrast	Participants (1)	Nonparticipants (2)	Difference (3)	Standard error (4)	*p*-value (5)	SB (6)	ASB % change (7)
Age: 17 years or younger	Before IPW	0.05	0.04	0.01	0	0	6.11	
	After IPW	0.05	0.06	0	0	0.23	-1.33	78.21
Age: 18 or 19 years	Before IPW	0.14	0.12	0.02	0	0	6.56	
	After IPW	0.14	0.15	-0.01	0	0.01	-2.69	59.02
Age: 20–34 years	Before IPW	0.05	0.06	0	0	0.09	-1.87	
	After IPW	0.05	0.05	0	0	0.87	0.17	90.95
Race/ethnicity: Hispanic	Before IPW	0.09	0.06	0.03	0	0	10.76	
	After IPW	0.09	0.09	-0.01	0	0.07	-2.05	80.94
Race/ethnicity: Non-Hispanic white	Before IPW	0.21	0.26	-0.05	0	0	-11.78	
	After IPW	0.21	0.21	0	0	0.52	-0.65	94.52
Race/ethnicity: Non-Hispanic American Indian/Alaskan Native	Before IPW	0	0	0	0	0.15	1.66	
	After IPW	0	0	0	0	0.70	-0.43	73.82
Race/ethnicity: Non-Hispanic Asian/Pacific Islander	Before IPW	0.01	0.02	-0.01	0	0	-5.22	
	After IPW	0.01	0.01	0	0	0.57	-0.53	89.83
Race/ethnicity: Non-Hispanic other race	Before IPW	0	0	0	0	0.7	-0.43	
	After IPW	0	0	0	0	0.77	0.29	32.60
Race/ethnicity: Non-Hispanic multirace	Before IPW	0.03	0.03	0	0	0.65	0.51	
	After IPW	0.03	0.03	0	0	0.89	0.15	70.82
Race/ethnicity: Unknown	Before IPW	0.01	0.01	0	0	0.09	-1.89	
	After IPW	0.01	0.01	0	0	0.62	0.47	74.83
Foreign-born: Yes	Before IPW	0.1	0.08	0.02	0	0	6.18	
	After IPW	0.1	0.1	0	0	0.19	-1.41	77.23
Married: Yes	Before IPW	0.32	0.34	-0.01	0.01	0.03	-2.46	
	After IPW	0.32	0.31	0.01	0	0.02	2.33	5.47
Education: Less than high school	Before IPW	0.3	0.26	0.04	0.01	0	8.27	
	After IPW	0.3	0.3	-0.01	0	0.21	-1.33	83.97
Education: Some college, no degree	Before IPW	0.3	0.34	-0.04	0.01	0	-8.30	
	After IPW	0.3	0.29	0.01	0	0.05	1.98	76.19
Education: College degree	Before IPW	0.04	0.07	-0.03	0	0	-13.22	
	After IPW	0.04	0.04	0	0	0.56	0.51	96.16

Variable	Contrast	Mean		Student's T-test			Standardized bias	
		Participants (1)	Nonparticipants (2)	Difference (3)	Standard error (4)	*p*-value (5)	SB (6)	ASB % change (7)
Rural residence	Before IPW	0.4	0.26	0.14	0.01	0	30.37	
	After IPW	0.4	0.4	0	0.01	0.54	-0.67	97.80
Family income > 100% FPL	Before IPW	0.12	0.13	0	0	0.28	-1.22	
	After IPW	0.12	0.12	0	0	0.78	-0.29	76.46
Family income*(household income 0–100% FPL)	Before IPW	10.54	10.07	0.47	0.28	0.09	1.94	
	After IPW	10.54	10.31	0.23	0.25	0.37	0.93	52.10
Family income*(household income > 100% FPL)	Before IPW	18.19	19.17	-0.97	0.58	0.09	-1.88	
	After IPW	18.19	18.21	-0.01	0.52	0.98	-0.03	98.58
Unmatched infant	Before IPW	0.01	0.04	-0.03	0	0	-18.85	
	After IPW	0.01	0.01	0	0	0.96	-0.03	99.82
Unmatched mother	Before IPW	0.01	0.03	-0.02	0	0	-12.50	
	After IPW	0.01	0.01	0	0	0.86	-0.14	98.90
Prenatal care from public clinic	Before IPW	0.39	0.2	0.19	0.01	0	42.11	
	After IPW	0.39	0.41	-0.02	0.01	0	-3.56	91.55
SNAP enrollment (mother)	Before IPW	0.71	0.64	0.07	0.01	0	14.85	
	After IPW	0.71	0.71	-0.01	0	0.14	-1.46	90.19
TANF enrollment (mother)	Before IPW	0.19	0.19	0	0	1.00	0	
	After IPW	0.19	0.19	0	0	0.91	0.11	-2,965.58
Aged, blind, and/or disabled Medicaid enrollment (mother)	Before IPW	0.03	0.02	0.01	0	0	6.21	
	After IPW	0.03	0.03	0	0	0.27	-1.26	79.63
SNAP enrollment (infant)	Before IPW	0.46	0.37	0.09	0.01	0	17.75	
	After IPW	0.46	0.47	-0.01	0.01	0.01	-2.57	85.53
Medicaid managed care beneficiary (mother or infant)	Before IPW	0.61	0.69	-0.08	0.01	0	-15.99	
	After IPW	0.61	0.62	-0.01	0	0.03	-2.33	85.42
Infant's gender is male	Before IPW	0.51	0.52	-0.01	0.01	0.18	-1.50	
	After IPW	0.51	0.51	0	0.01	0.77	0.30	80.25
Pre-pregnancy body mass index (BMI): Less than 18.5 (underweight)	Before IPW	0.05	0.06	0	0	0.65	-0.52	
	After IPW	0.05	0.05	0	0	0.29	1.06	-104.92
Pre-pregnancy body mass index (BMI): 25 to 29.9 (overweight)	Before IPW	0.23	0.23	0	0	0.85	0.22	
	After IPW	0.23	0.23	0	0	0.95	-0.06	71.45
Pre-pregnancy body mass index (BMI): 30 to 40.4 (obese)	Before IPW	0.22	0.18	0.04	0	0	10.86	
	After IPW	0.22	0.22	0	0	0.29	-1.14	89.53

Variable	Contrast	Mean		Student's T-test			Standardized bias	
		Participants (1)	Nonparticipants (2)	Difference (3)	Standard error (4)	*p*-value (5)	SB (6)	ASB % change (7)
Pre-pregnancy body mass index (BMI): 40.5 or more (extremely obese)	Before IPW	0.06	0.04	0.02	0	0	9.32	
	After IPW	0.06	0.06	0	0	0.34	-1.07	88.51
Pre-pregnancy body mass index (BMI): Unknown	Before IPW	0.02	0.02	0	0	0.46	0.83	
	After IPW	0.02	0.03	0	0	0.19	-1.40	-68.39
Smoked three months before pregnancy: Yes	Before IPW	0.38	0.36	0.02	0.01	0	4.58	
	After IPW	0.38	0.39	-0.01	0	0.17	-1.44	68.64
Smoked three months before pregnancy: Unknown	Before IPW	0.01	0.01	0	0	0.23	-1.33	
	After IPW	0.01	0.01	0	0	0.34	0.92	30.78
Number of cigarettes/day before pregnancy*(smoked = yes)	Before IPW	6.47	5.93	0.54	0.12	0	5.09	
	After IPW	6.47	6.68	-0.21	0.11	0.07	-1.95	61.71
Previous cesarean delivery	Before IPW	0.12	0.13	-0.01	0	0.01	-2.85	
	After IPW	0.12	0.12	0	0	0.96	0.06	98.07
Previous preterm birth	Before IPW	0.03	0.04	-0.01	0	0	-4.00	
	After IPW	0.03	0.03	0	0	0.83	-0.21	94.82
Previous other poor birth outcomes	Before IPW	0.02	0.02	0	0	0.15	1.64	
	After IPW	0.02	0.02	0	0	0.50	-0.73	55.43
Pre-pregnancy diabetes	Before IPW	0.01	0.01	0	0	0	3.95	
	After IPW	0.01	0.01	0	0	0.27	-1.28	67.60
Pre-pregnancy hypertension	Before IPW	0.02	0.01	0	0	0.16	1.60	
	After IPW	0.02	0.02	0	0	0.94	0.08	95.19
Inter-pregnancy interval: Short (6–17 months)	Before IPW	0.16	0.17	-0.01	0	0	-3.73	
	After IPW	0.16	0.15	0	0	0.33	0.97	74.02
Inter-pregnancy interval: Very short (< 6 months)	Before IPW	0.08	0.09	-0.01	0	0.01	-3.00	
	After IPW	0.08	0.08	0	0	0.36	0.92	69.39
Previous live births: 1	Before IPW	0.28	0.28	0	0.01	0.5	0.76	
	After IPW	0.28	0.27	0.01	0	0.09	1.74	-127.96
Previous live births: 2	Before IPW	0.16	0.19	-0.03	0	0	-6.95	
	After IPW	0.16	0.16	0	0	0.34	0.95	86.40
Previous live births: 3	Before IPW	0.07	0.1	-0.03	0	0	-9.69	
	After IPW	0.07	0.07	0	0	0.68	0.39	95.93
Previous live births: 4	Before IPW	0.03	0.04	-0.01	0	0	-5.14	
	After IPW	0.03	0.03	0	0	0.61	0.48	90.62

Variable	Contrast	Mean		Student's T-test			Standardized bias	
		Participants (1)	Nonparticipants (2)	Difference (3)	Standard error (4)	*p*-value (5)	SB (6)	ASB % change (7)
Previous live births: 5 or more	Before IPW	0.02	0.03	-0.01	0	0	-7.07	
	After IPW	0.02	0.02	0	0	0.65	0.41	94.14
Previous live births: Unknown	Before IPW	0.01	0.01	0	0	0.08	-1.94	
	After IPW	0.01	0.01	0	0	0.25	-1.14	40.95
Previous terminations: 1	Before IPW	0.17	0.18	-0.01	0	0.07	-2.01	
	After IPW	0.17	0.17	0	0	0.95	-0.07	96.51
Previous terminations: 2	Before IPW	0.06	0.06	0	0	0.96	0.06	
	After IPW	0.06	0.06	0	0	0.60	0.54	-820.83
Previous terminations: 3	Before IPW	0.02	0.02	0	0	0.97	-0.05	
	After IPW	0.02	0.02	0	0	0.80	-0.27	-472.55
Previous terminations: 4	Before IPW	0.01	0.01	0	0	0.92	0.11	
	After IPW	0.01	0.01	0	0	0.27	1.09	-897.16
Previous terminations: 5 or more	Before IPW	0.01	0.01	0	0	0.13	-1.67	
	After IPW	0.01	0.01	0	0	0.68	0.39	76.54
Previous terminations: Unknown	Before IPW	0.01	0.01	0	0	0	-3.46	
	After IPW	0.01	0.01	0	0	0.36	-0.87	74.69
Gestational age: (weeks)	Before IPW	38.58	38.35	0.23	0.02	0	10.68	
	After IPW	38.58	38.60	-0.02	0.02	0.26	-1.04	90.26
Gestational age: 37 or 38 weeks	Before IPW	0.28	0.27	0.01	0.01	0.10	1.86	
	After IPW	0.28	0.28	0.00	0.00	0.88	-0.16	91.52
Gestational age: 33–36 weeks	Before IPW	0.07	0.09	-0.02	0	0	-6.84	
	After IPW	0.07	0.07	0	0	0.22	1.17	82.85
Gestational age: 32 weeks or fewer	Before IPW	0.01	0.02	-0.01	0	0	-8.50	
	After IPW	0.01	0.01	0	0	0.71	0.32	96.25

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate.

This table examines the improvement in balance between the WIC participants and nonparticipants achieved through IPW on individual characteristics included as predictors in the propensity score model. The means (or proportions) for each variable are presented for the two groups. In addition, the difference in the means (or proportions) is calculated (with the standard error) and the standardized bias (percent of one standard deviations). Mother and infant characteristics are defined in Chapter III, Table III.4. The proportions for categorical variables in columns (1) and (2) do not total to 1 due to rounding and because base categories are not included. *p*-values in column (5) are from Student's t-tests (chi-squared tests are unavailable with weighted samples). Standardize biases are presented as the percentage of one standard deviation. These estimates are calculated before and after IPW. The propensity score model included gestational age and the full set of covariates shown in Chapter III, Table III.4.

ASB = absolute value of SB; BMI = body mass index; FPL = Federal poverty level; IPW = inverse probability weighting; SB = standardized bias; SNAP = Supplemental Nutrition Assistance Program; TANF = Temporary Assistance for Needy Families; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table D.OK.2. Comparisons of mother and infant characteristics for WIC participants and nonparticipants in the prenatal analysis, before and after inverse probability weighting

		Mean		Student's T-test			Standardized bias	
Variable	Contrast	Participants (1)	Nonparticipants (2)	Difference (3)	Standard error (4)	*p*-value (5)	SB (6)	ASB % change (7)
Age: 17 years or younger	Before IPW	0.06	0.04	0.02	0	0	11.41	
	After IPW	0.06	0.06	0	0	0.87	-0.20	98.22
Age: 18 or 19 years	Before IPW	0.14	0.09	0.04	0	0	14.07	
	After IPW	0.14	0.14	0	0	0.44	0.95	93.28
Age: 20–34 years	Before IPW	0.05	0.06	-0.01	0	0	-4.01	
	After IPW	0.05	0.06	0	0	0.24	-1.30	67.6
Race/Ethnicity: Hispanic	Before IPW	0.20	0.13	0.07	0	0	19.41	
	After IPW	0.20	0.21	-0.01	0	0.11	-1.99	89.74
Race/Ethnicity: Non-Hispanic white	Before IPW	0.10	0.13	-0.03	0	0	-8.45	
	After IPW	0.10	0.10	0	0	0.53	0.67	92.06
Race/Ethnicity: Non-Hispanic American Indian/Alaskan Native	Before IPW	0.10	0.13	-0.03	0	0	-9.57	
	After IPW	0.10	0.10	0	0	0.62	-0.54	94.36
Race/Ethnicity: Non-Hispanic Asian/Pacific Islander	Before IPW	0.02	0.03	-0.01	0	0	-7.57	
	After IPW	0.02	0.02	0	0	0.45	-0.76	89.92
Race/Ethnicity: Non-Hispanic Other race	Before IPW	0	0	0	0	0.49	0.92	
	After IPW	0	0	0	0	0.99	-0.01	98.89
Race/Ethnicity: Non-Hispanic multi-race	Before IPW	0.05	0.05	-0.01	0	0.01	-3.13	
	After IPW	0.05	0.05	0	0	0.49	0.75	76.14
Foreign-born: Yes	Before IPW	0.16	0.12	0.04	0	0	12.76	
	After IPW	0.16	0.17	-0.01	0	0.03	-2.64	79.32
Married: Yes	Before IPW	0.39	0.42	-0.03	0.01	0	-6.33	
	After IPW	0.39	0.39	0	0.01	0.59	-0.61	90.36
Education: Less than high school	Before IPW	0.33	0.28	0.05	0.01	0	11.76	
	After IPW	0.33	0.33	0	0.01	0.99	0.02	99.86
Education: some college, no degree	Before IPW	0.27	0.32	-0.05	0.01	0	-11.87	
	After IPW	0.27	0.27	0	0.01	0.41	-0.92	92.25
Education: college degree	Before IPW	0.04	0.07	-0.03	0	0	-13.87	
	After IPW	0.04	0.04	0	0	0.42	-0.79	94.32
Rural residence	Before IPW	0.45	0.35	0.1	0.01	0	20.37	
	After IPW	0.45	0.45	0	0.01	0.86	-0.21	98.97

Variable	Contrast	Mean		Student's T-test			Standardized bias	
		Participants (1)	Nonparticipants (2)	Difference (3)	Standard error (4)	*p*-value (5)	SB (6)	ASB % change (7)
Family income >100% FPL	Before IPW	0.19	0.21	-0.02	0.01	0	-4.57	
	After IPW	0.19	0.19	0	0	0.81	-0.27	94.2
Family income*(household income 0–100% FPL)	Before IPW	22.09	17.85	4.23	0.55	0	8.75	
	After IPW	22.09	22.29	-0.2	0.4	0.62	-0.41	95.31
Family income*(household income > 100% FPL)	Before IPW	29.86	33.63	-3.77	0.98	0	-4.87	
	After IPW	29.86	29.9	-0.04	0.84	0.96	-0.05	98.89
Unmatched infant	Before IPW	0.02	0.04	-0.02	0	0	-13.48	
	After IPW	0.02	0.02	0	0	0.36	-0.85	93.71
Prenatal care from public clinic	Before IPW	0.11	0.05	0.06	0	0	21.53	
	After IPW	0.11	0.11	0	0	0.83	-0.28	98.68
TANF enrollment (mother)	Before IPW	0.2	0.19	0.01	0.01	0.29	1.36	
	After IPW	0.2	0.19	0.01	0	0.07	2.04	-49.55
Aged, Blind, and/or Disabled Medicaid enrollment (mother)	Before IPW	0.01	0.00	0	0	0	5.02	
	After IPW	0.01	0.0	0	0	0.5	0.89	82.18
Infant's gender is male	Before IPW	0.51	0.51	0.01	0.01	0.19	1.68	
	After IPW	0.51	0.52	0	0.01	0.91	-0.12	92.73
Pre-pregnancy body mass index (BMI): less than 18.5 (underweight)	Before IPW	0.05	0.06	-0.01	0	0.02	-2.88	
	After IPW	0.05	0.05	0	0	0.52	0.70	75.65
Pre-pregnancy body mass index (BMI): 25 to 29.9 (overweight)	Before IPW	0.24	0.25	-0.01	0.01	0.37	-1.17	
	After IPW	0.24	0.24	0	0	0.95	0.07	94.01
Pre-pregnancy body mass index (BMI): 30 to 40.4 (obese)	Before IPW	0.22	0.19	0.04	0.01	0	9.02	
	After IPW	0.22	0.23	0	0	0.37	-1.06	88.2
Pre-pregnancy body mass index (BMI): 40.5 or more (extremely obese)	Before IPW	0.06	0.05	0.01	0	0	5.72	
	After IPW	0.06	0.06	0	0	0.66	-0.54	90.6
Pre-pregnancy body mass index (BMI): unknown	Before IPW	0.01	0.01	0	0	0.99	-0.02	
	After IPW	0.01	0.01	0	0	0.67	0.48	-2187.15
Smoked three months before pregnancy: yes	Before IPW	0.16	0.17	0	0	0.31	-1.3	
	After IPW	0.16	0.15	0.01	0	0.16	1.57	-21.24
Smoked three months before pregnancy: unknown	Before IPW	0.10	0.10	0	0	0.52	0.84	
	After IPW	0.10	0.10	0	0	0.83	0.25	69.72
Number of cigarettes/day before pregnancy*(smoked = yes)	Before IPW	1.69	1.71	-0.02	0.06	0.78	-0.35	
	After IPW	1.69	1.63	0.06	0.06	0.25	1.3	-268.18

Variable	Contrast	Mean		Student's T-test			Standardized bias	
		Participants (1)	Nonparticipants (2)	Difference (3)	Standard error (4)	*p*-value (5)	SB (6)	ASB % change (7)
Previous cesarean delivery	Before IPW	0.14	0.15	-0.01	0	0.03	-2.72	
	After IPW	0.14	0.15	0	0	0.30	-1.18	56.81
Previous preterm birth	Before IPW	0.02	0.02	0	0	0.13	-1.95	
	After IPW	0.02	0.02	0	0	0.78	0.31	84.11
Previous other poor birth outcomes	Before IPW	0.01	0.01	0	0	0.59	0.69	
	After IPW	0.01	0.02	0	0	0.48	-0.83	-19.74
Pre-pregnancy diabetes	Before IPW	0.01	0.01	0	0	0.1	2.18	
	After IPW	0.01	0.01	0	0	0.12	-1.98	9.04
Pre-pregnancy hypertension	Before IPW	0.01	0.01	0	0	0.1	2.16	
	After IPW	0.01	0.02	0	0	0.56	-0.71	67.17
Inter-pregnancy interval: short (6–17 months)	Before IPW	0.16	0.20	-0.04	0	0	-9.20	
	After IPW	0.16	0.16	0	0	0.71	-0.41	95.57
Inter-pregnancy interval: very short (< 6 months)	Before IPW	0.08	0.10	-0.02	0	0	-8.48	
	After IPW	0.08	0.08	0	0	0.53	-0.68	91.96
Previous live births: 1	Before IPW	0.28	0.3	-0.02	0.01	0	-5.04	
	After IPW	0.28	0.28	-0.01	0.01	0.1	-1.86	63.12
Previous live births: 2	Before IPW	0.17	0.21	-0.04	0	0	-9.27	
	After IPW	0.17	0.17	0	0	0.66	-0.48	94.85
Previous live births: 3	Before IPW	0.08	0.11	-0.03	0	0	-10.71	
	After IPW	0.08	0.08	0	0	0.53	0.66	93.86
Previous live births: 4	Before IPW	0.03	0.04	-0.01	0	0	-5.73	
	After IPW	0.03	0.03	0	0	0.74	0.35	93.88
Previous live births: 5 or more	Before IPW	0.02	0.04	-0.01	0	0	-6.24	
	After IPW	0.02	0.02	0	0	0.59	0.56	91.09
Previous terminations: 1	Before IPW	0.13	0.13	-0.01	0	0.16	-1.81	
	After IPW	0.13	0.13	0	0	0.9	-0.15	91.86
Previous terminations: 2	Before IPW	0.05	0.05	0	0	0.82	-0.29	
	After IPW	0.05	0.05	0	0	0.92	-0.11	62.64
Previous terminations: 3	Before IPW	0.01	0.01	0	0	0.42	-1.03	
	After IPW	0.01	0.01	0	0	0.54	-0.7	32.23
Previous terminations: 4	Before IPW	0.01	0.01	0	0	0.69	-0.51	
	After IPW	0.01	0.01	0	0	0.65	0.50	1.15

Variable	Contrast	Mean		Student's T-test			Standardized bias	
		Participants (1)	Nonparticipants (2)	Difference (3)	Standard error (4)	*p*-value (5)	SB (6)	ASB % change (7)
Previous terminations: 5 or more	Before IPW	0.01	0.01	0	0	0.91	0.15	
	After IPW	0.01	0.01	0	0	1.00	0	97.70
Gestational age: (weeks)	Before IPW	38.39	38.15	0.24	0.03	0	11.40	
	After IPW	38.39	38.38	0.01	0.02	0.61	0.54	95.27
Gestational age: 37 or 38 weeks	Before IPW	0.30	0.32	-0.02	0.01	0.01	-3.37	
	After IPW	0.30	0.30	0	0.01	0.93	-0.09	97.21
Gestational age: 33–36 weeks	Before IPW	0.08	0.1	-0.02	0	0	-5.89	
	After IPW	0.08	0.09	0	0	0.21	-1.37	76.73
Gestational age: 32 weeks or fewer	Before IPW	0.01	0.02	-0.01	0	0	-7.39	
	After IPW	0.01	0.01	0	0	0.72	0.34	95.36

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

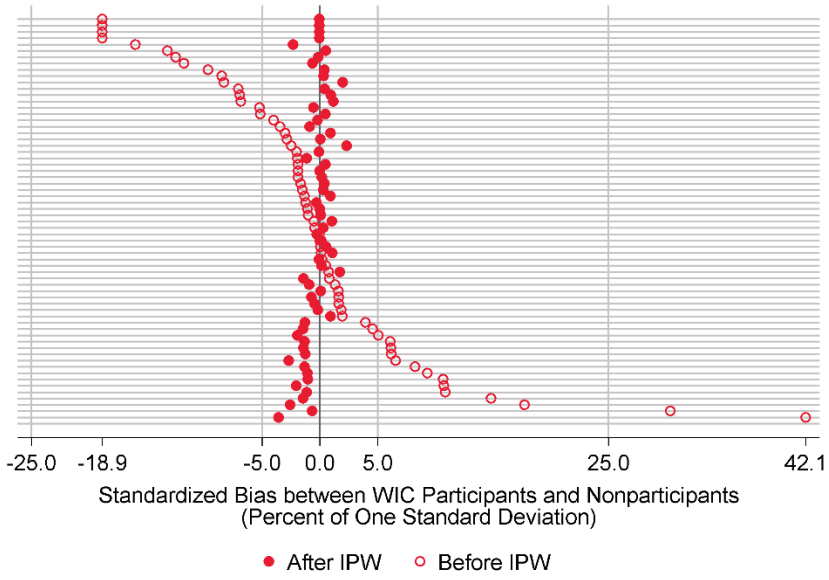
Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate.

This table examines the improvement in balance between the WIC participants and nonparticipants achieved through IPW on individual characteristics included as predictors in the propensity score model. The means (or proportions) for each variable are presented for the two groups.

In addition, the difference in the means (or proportions) is calculated (with the standard error) and the standardized bias (percent of one standard deviations). Mother and infant characteristics are defined in Chapter III, Table III.4. The proportions for categorical variables in columns (1) and (2) do not total to 1 due to rounding and because base categories are not included. *p*-values in column (5) are from Student's t-tests (chi-squared tests are unavailable with weighted samples). Standardize biases are presented as the percent of one standard deviation. These estimates are calculated before IPW, as well as after IPW. The propensity score model included gestational age and the full set of covariates shown in Chapter III, Table III.4.

ASB = absolute value of SB; BMI = body mass index; FPL = Federal poverty level; IPW = inverse probability weighting; SB = standardized bias; TANF = Temporary Assistance for Needy Families; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Figure D.MO.2. Standardized biases for mother and infant characteristics in the prenatal analysis, before and after IPW



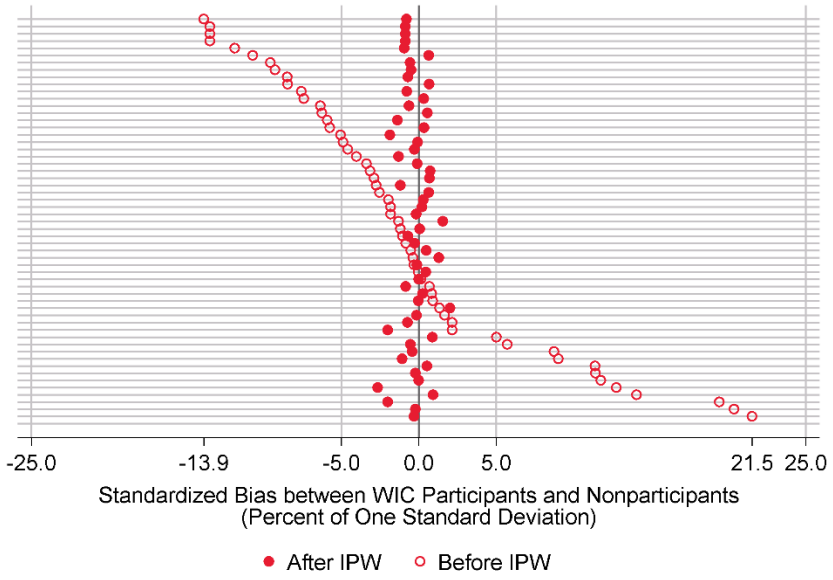
Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate.

This figure examines the improvement in balance between the WIC participants and nonparticipants achieved through IPW on individual characteristics included as predictors in the propensity score model. That is, this figure plots the standardized bias for each characteristic—column (6) in Table D.MO.2—before and after IPW. Characteristics are sorted by the standardized bias before IPW.

IPW = inverse probability weighting; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Figure D.OK.2. Standardized biases for mother and infant characteristics in the prenatal analysis, before and after IPW



Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate.

This figure examines the improvement in balance between the WIC participants and nonparticipants achieved through IPW on individual characteristics included as predictors in the propensity score model. That is, this figure plots the standardized bias for each characteristic—column (6) in Table D.OK.2—before and after IPW. Characteristics are sorted by the standardized bias before IPW.

IPW = inverse probability weighting; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table D.MO.3. Summary measures of balance on mother and infant characteristics for WIC participants and nonparticipants in the prenatal analysis, before and after inverse probability weighting

		Logit model[b]			Omnibus test[c]	
	Mean ASB across covariates[a]	Pseudo R2	chi-squared	p-value	chi-squared	p-value
Before IPW	6.67	0.07	3,277	0.00	3,440	0.00
After IPW	0.85	0.00	73.0	0.12	33.8	1.00

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate.

This table examines the improvement in balance between the WIC participants and nonparticipants achieved through IPW on individual characteristics included as predictors in the propensity score model. That is, this table summarizes the differences observed in Table D.MO.2.

[a] This measure is the mean of the absolute values of the SBs in column (6) in Table D.MO.2.

[b] This measure of covariate balance involves examining the goodness of fit of the propensity score regression before and after matching by re-estimating the propensity score model with the matched sample. Before IPW, the variables in the model predict WIC participation, as would be expected given that the variables were selected in part for their ability to predict participation. A low pseudo-R^2 and/or failure to reject the hypothesis that the variables do not (jointly) predict participation using a log-likelihood ratio test, obtained with the matched sample, would indicate success of IPW in balancing the characteristics of the WIC participants and the matched comparison group. That is, if the covariates in the model no longer predict participation after IPW, the WIC participants and nonparticipants do not differ statistically on those characteristics.

[c] This test checks covariate balance between WIC beneficiaries and the matched comparison group of nonparticipants using a single "omnibus" test statistic. The omnibus test is based on the t-tests for the difference in means between the two groups across the set of covariates in Table D.MO.2. After performing each t-test (using a linear regression of the covariate on a WIC participation dummy), the estimation results—parameter estimates and associated covariance matrices—are combined into one parameter vector and simultaneous covariance matrix of the sandwich/robust type. After estimating the covariance matrix of the multivariate normal distribution of the estimators of the models, the omnibus test checks that the WIC participation dummies are jointly equal to zero. The advantage of the omnibus test is that it generates a single probability statement through one *p*-value capturing whether or not the groups differ statistically across all of the variables as a whole, and accounts for correlations across characteristics.

ASB = absolute value of SB; IPW = inverse probability weighting; SB = standardized bias; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table D.OK.3. Summary measures of balance on mother and infant characteristics for WIC participants and nonparticipants in the prenatal analysis, before and after inverse probability weighting

		Logit model[b]			Omnibus test[c]	
	Mean ASB across covariates[a]	Pseudo R^2	chi-squared	*p*-value	chi-squared	*p*-value
Before IPW	6.38	0.05	1,843	0.00	1,943	0.00
After IPW	0.72	0.00	25.4	1.00	15.5	1.00

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate.

This table examines the improvement in balance between the WIC participants and nonparticipants achieved through IPW on individual characteristics included as predictors in the propensity score model. That is, this table summarizes the differences observed in Table D.OK.2.

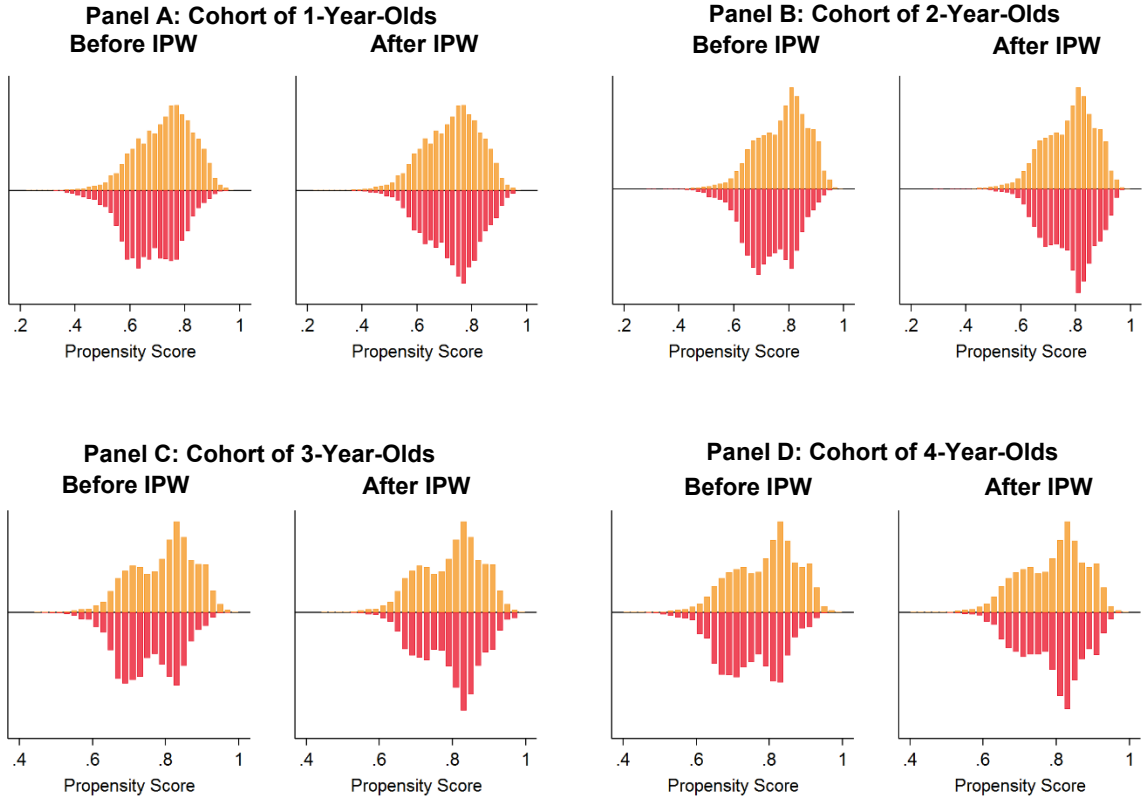
[a] This measure is the mean of the absolute values of the SBs in column (6) in Table D.OK.2.

[b] This measure of covariate balance involves examining the goodness of fit of the propensity score regression before and after matching by reestimating the propensity score model with the matched sample. Before IPW, the variables in the model predict WIC participation, as would be expected given that the variables were selected in part for their ability to predict participation. A low pseudo-R^2 and/or failure to reject the hypothesis that the variables do not (jointly) predict participation using a log-likelihood ratio test, obtained with the matched sample, would indicate success of IPW in balancing the characteristics of the WIC participants and the matched comparison group. That is, if the covariates in the model no longer predict participation after IPW, the WIC participants and nonparticipants do not differ statistically on those characteristics.

[c] This test checks covariate balance between WIC beneficiaries and the matched comparison group of nonparticipants using a single "omnibus" test statistic. The omnibus test is based on the t-tests for the difference in means between the two groups across the set of covariates in Table D.OK.2. After performing each t-test (using a linear regression of the covariate on a WIC participation dummy), the estimation results—parameter estimates and associated covariance matrices—are combined into one parameter vector and simultaneous covariance matrix of the sandwich/robust type. After estimating the covariance matrix of the multivariate normal distribution of the estimators of the models, the omnibus test checks that the WIC participation dummies are jointly equal to zero. The advantage of the omnibus test is that it generates a single probability statement through one *p*-value capturing whether or not the groups differ statistically across all of the variables as a whole, and accounts for correlations across characteristics.

ASB = absolute value of SB; IPW = inverse probability weighting; SB = standardized bias; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Figure D.MO.3. Comparison of the distribution of propensity scores for WIC participants and nonparticipants in the children's analysis, before and after IPW, by age cohort



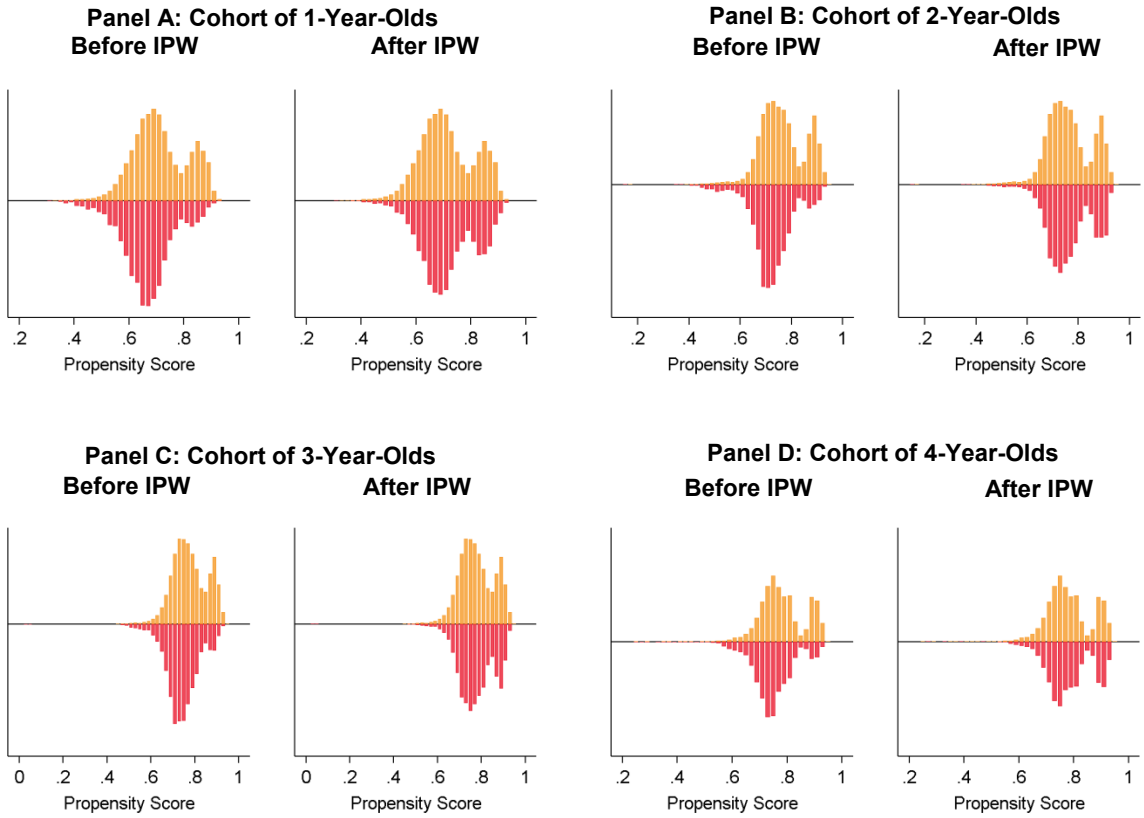
Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on child Medicaid beneficiaries continuously enrolled from January to December 2010 linked with a Vital Records birth certificate.

In each panel, the figure on the left is a histogram with the distribution of the propensity scores without IPW, and the figure on the right is a histogram of the propensity scores with IPW. WIC participants are presented in the top part of each histogram (bars facing upward) and nonparticipants are presented in the bottom part (bars facing downward) of each histogram. Table D.MO.4 provides summary statistics for these distributions.

IPW = inverse probability weighting; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Figure D.OK.3. Comparison of the distribution of propensity scores for WIC participants and nonparticipants in the children's analysis, before and after IPW, by age cohort



Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on child Medicaid beneficiaries continuously enrolled from January to December 2010 linked with a Vital Records birth certificate.

In each panel, the figure on the left is a histogram with the distribution of the propensity scores without IPW, and the figure on the right is a histogram of the propensity scores with IPW. WIC participants are presented in the top part of each histogram (bars facing upward) and nonparticipants are presented in the bottom part (bars facing downward) of each histogram. Table D.OK.4 provides summary statistics for these distributions.

IPW = inverse probability weighting; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table D.MO.4. Diagnostic tests to assess the quality of the balance of the propensity score distributions for WIC participants and nonparticipants in the children's analysis, before and after inverse probability weighting, by age cohort

	Mean of propensity score				Student's T-test				Ratio of variances	
	Participants		Nonparticipants		Difference		*p*-value		(Var_P/Var_N)	
	Before IPW	After IPW	Before IPW	After IPW	Before IPW	After IPW	Before IPW	After IPW	Before IPW	After IPW
Cohort of 1-year-olds										
Whole sample	**0.73**	**0.73**	**0.67**	**0.73**	**0.05**	**0.00**	**0.00**	**0.43**	**0.97**	**1.03**
Quantile 1	0.59	0.59	0.54	0.59	0.05	0.00	0.12	0.00	1.00	1.17
Quantile 2	0.70	0.70	0.64	0.70	0.06	0.00	0.03	0.00	1.30	0.97
Quantile 3	0.77	0.77	0.72	0.77	0.06	0.00	0.00	0.00	0.64	1.15
Quantile 4	0.85	0.85	0.80	0.85	0.05	0.00	0.07	0.00	0.69	0.82
Quantiles 1 to 4 (joint F-test)							0.00	0.00		
Cohort of 2-year-olds										
Whole sample	**0.78**	**0.78**	**0.73**	**0.78**	**0.05**	**0.00**	**0.00**	**0.55**	**0.95**	**1.02**
Quantile 1	0.65	0.65	0.61	0.65	0.04	0.00	0.00	0.06	0.86	1.08
Quantile 2	0.76	0.76	0.70	0.75	0.06	0.00	0.00	0.00	1.81	0.99
Quantile 3	0.82	0.82	0.77	0.82	0.05	0.00	0.00	0.00	0.44	1.04
Quantile 4	0.89	0.89	0.85	0.89	0.04	0.00	0.00	0.23	0.65	0.93
Quantiles 1 to 4 (joint F-test)							0.00	0.00		
Cohort of 3-year-olds										
Whole sample	**0.80**	**0.80**	**0.75**	**0.79**	**0.04**	**0.00**	**0.00**	**0.39**	**1.03**	**1.04**
Quantile 1	0.68	0.68	0.65	0.68	0.03	0.00	0.00	0.04	1.02	1.12
Quantile 2	0.77	0.77	0.72	0.77	0.06	0.00	0.00	0.92	2.15	0.99
Quantile 3	0.83	0.83	0.79	0.83	0.05	0.00	0.00	0.00	0.34	1.24
Quantile 4	0.90	0.90	0.86	0.89	0.04	0.00	0.00	0.00	0.74	0.69
Quantiles 1 to 4 (joint F-test)							0.00	0.00		
Cohort of 4-year-olds										
Whole sample	**0.79**	**0.79**	**0.75**	**0.79**	**0.05**	**0.00**	**0.00**	**0.10**	**1.03**	**1.07**
Quantile 1	0.67	0.67	0.64	0.67	0.03	0.00	0.00	0.02	1.11	1.12
Quantile 2	0.77	0.77	0.71	0.77	0.06	0.00	0.00	0.64	1.98	1.05
Quantile 3	0.83	0.83	0.78	0.83	0.05	0.00	0.00	0.00	0.35	1.24
Quantile 4	0.89	0.89	0.85	0.89	0.04	0.00	0.00	0.00	0.66	0.82
Quantiles 1 to 4 (joint F-test)							0.00	0.00		

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on child Medicaid beneficiaries continuously enrolled from January to December 2010 linked with a Vital Records birth certificate.

This table presents summary statistics on the distribution of the propensity scores for WIC participants and nonparticipants, before and after IPW. The propensity score model included gestational age and the full set of covariates shown in Chapter IV, Table IV.4.These distributions are presented graphically in Figure D.MO.3.

IPW = inverse probability weighting; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table D.OK.4. Diagnostic tests to assess the quality of the balance of the propensity score distributions for WIC participants and nonparticipants in the children's analysis, before and after inverse probability weighting, by age cohort

	Mean of propensity score				Student's T-test				Ratio of variances	
	Participants		Nonparticipants		Difference		*p*-value		(Var_P/Var_N)	
	Before IPW	After IPW	Before IPW	After IPW	Before IPW	After IPW	Before IPW	After IPW	Before IPW	After IPW
Cohort of 1-year-olds										
Whole sample	**0.72**	**0.72**	**0.67**	**0.71**	**0.05**	**0.00**	**0.00**	**0.41**	**1.13**	**1.04**
Quantile 1	0.59	0.59	0.55	0.59	0.04	0.00	0.00	0.44	0.69	0.90
Quantile 2	0.68	0.68	0.64	0.68	0.03	0.00	0.00	0.01	1.15	1.14
Quantile 3	0.74	0.74	0.69	0.74	0.05	0.00	0.00	0.07	2.99	1.13
Quantile 4	0.85	0.85	0.79	0.85	0.07	0.01	0.00	0.00	0.32	0.87
Quantiles 1 to 4 (joint F-test)							0.00	0.00		
Cohort of 2-year-olds										
Whole sample	**0.77**	**0.77**	**0.72**	**0.77**	**0.04**	**0.00**	**0.00**	**0.78**	**1.05**	**1.01**
Quantile 1	0.66	0.66	0.62	0.66	0.04	0.00	0.00	0.65	0.54	1.00
Quantile 2	0.73	0.73	0.70	0.73	0.03	0.00	0.00	0.41	1.57	1.09
Quantile 3	0.78	0.78	0.74	0.78	0.04	0.00	0.00	0.95	2.19	0.92
Quantile 4	0.89	0.89	0.83	0.88	0.06	0.00	0.00	0.04	0.24	0.90
Quantiles 1 to 4 (joint F-test)							0.00	0.47		
Cohort of 3-year-olds										
Whole sample	**0.78**	**0.78**	**0.74**	**0.78**	**0.04**	**0.00**	**0.00**	**0.52**	**1.05**	**1.04**
Quantile 1	0.68	0.68	0.65	0.68	0.03	0.00	0.00	0.89	0.51	0.97
Quantile 2	0.75	0.75	0.72	0.75	0.03	0.00	0.00	0.07	1.28	0.99
Quantile 3	0.80	0.80	0.76	0.80	0.04	0.00	0.00	0.79	2.09	1.20
Quantile 4	0.89	0.89	0.84	0.88	0.05	0.00	0.00	0.00	0.33	0.93
Quantiles 1 to 4 (joint F-test)							0.00	0.00		
Cohort of 4-year-olds										
Whole sample	**0.78**	**0.78**	**0.75**	**0.78**	**0.04**	**0.00**	**0.00**	**0.90**	**1.07**	**0.99**
Quantile 1	0.69	0.69	0.65	0.69	0.04	0.00	0.00	0.77	0.53	1.04
Quantile 2	0.75	0.75	0.73	0.75	0.03	0.00	0.00	0.06	1.15	0.92
Quantile 3	0.80	0.80	0.76	0.80	0.04	0.00	0.00	0.01	1.75	0.97
Quantile 4	0.90	0.90	0.84	0.90	0.06	0.00	0.00	0.55	0.26	1.05
Quantiles 1 to 4 (joint F-test)							0.00	0.43		

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on child Medicaid beneficiaries continuously enrolled from January to December 2010 linked with a Vital Records birth certificate.

This table presents summary statistics on the distribution of the propensity scores for WIC participants and nonparticipants, before and after IPW. The propensity score model included gestational age and the full set of covariates shown in Chapter IV, Table IV.4. These distributions are presented graphically in Figure D.OK.3.

IPW = inverse probability weighting; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table D.MO.5. Comparisons of child characteristics for WIC participants and nonparticipants in the children's analysis, before and after inverse probability weighting, by age cohort

Characteristic	1-year-olds			2-year-olds			3-year-olds			4-year-olds		
	SB before IPW	SB after IPW	ASB % change	SB before IPW	SB after IPW	ASB % change	SB before IPW	SB after IPW	ASB % change	SB before IPW	SB after IPW	ASB % change
Mother's age at child's birth: ≤ 17 years	9.30	0.02	99.75	9.23	0.87	90.55	10.83	3.28	69.73	11.41	2.62	77.08
Mother's age at child's birth: 18 or 19 years	4.56	0.73	83.92	8.03	1.54	80.82	10.57	-0.48	95.43	14.21	1.66	88.35
Mother's age at child's birth: ≥ 35 years	4.31	-1.60	62.79	1.68	-0.31	81.52	-1.78	-0.28	84.35	-2.98	-0.90	69.80
Mother's race/ethnicity: Hispanic	16.76	-1.61	90.42	14.59	-1.74	88.08	16.69	-3.30	80.24	16.10	-4.23	73.72
Mother's race/ethnicity: Black non-Hispanic	-12.64	-0.41	96.74	-15.19	-0.62	95.93	-17.31	-1.36	92.16	-18.19	-2.14	88.26
Mother's race/ethnicity: American Indian or Alaska Native	2.40	-0.39	83.89	3.41	-0.08	97.77	3.42	-0.25	92.81	3.56	0.61	82.76
Mother's race/ethnicity: Asian or Pacific Islander	-1.27	0.25	79.96	-3.54	0.65	81.78	-5.57	-0.33	94.08	-2.46	0.04	98.36
Mother's race/ethnicity: Other or multiple races	-2.56	-0.05	98.19	-2.14	-0.23	89.49	-2.17	-0.30	86.28	1.18	-0.72	38.93
Mother married	2.73	-0.76	72.12	-0.25	-0.28	-10.50	-3.11	-0.65	79.12	-3.38	-0.84	75.14
Mother's education: Less than high school	10.46	0.89	91.53	10.57	1.46	86.16	11.76	0.70	94.01	13.29	1.22	90.79
Mother's education: Some college credit but no degree	-11.17	-1.78	84.03	-11.01	-1.20	89.14	-11.21	-0.83	92.61	-12.13	-1.80	85.19
Mother's education: College degree	-9.14	-0.71	92.28	-9.50	-0.66	93.04	-10.60	-0.86	91.84	-8.58	-0.30	96.47
Mother's education: Unknown	1.11	-0.21	80.82	-0.05	-0.06	-22.61	1.63	-1.39	14.67	2.96	0.43	85.49
Rural residence	**25.07**†	0.46	98.16	**30.54**†	2.06	93.25	**32.10**†	2.80	91.26	**29.51**†	2.67	90.96
Family income: $0	-3.10	0.10	96.86	6.84	0.28	95.88	5.07	-0.10	98.06	3.43	1.19	65.27
Family income: > 100% FPL	6.06	-0.76	87.52	-0.20	-1.25	-533.11	3.26	-0.57	82.45	-0.22	-0.94	-320.85
Family income: Unknown	-0.76	-0.36	51.93	-1.17	0.18	84.63	-4.00	0.47	88.18	-0.68	-0.63	6.95
Family income as % FPL	2.51	0.17	93.38	0.02	-0.33	<-500	3.72	-0.56	84.90	-0.14	0.51	-278.73
Family income as % FPL * (income > 100% FPL)	5.07	-0.86	82.97	-1.40	-1.11	20.53	2.84	-0.66	76.74	-0.97	-0.90	7.50
SNAP participation	8.92	0.96	89.21	11.86	0.12	98.98	9.22	1.10	88.06	12.65	0.39	96.92
TANF Participation	8.01	1.31	83.59	12.77	0.06	99.51	11.97	0.32	97.37	14.30	2.93	79.53
Child's enrollment in Medicaid on the basis of aged, blind, and/or disabled eligibility	1.93	-1.61	16.57	1.21	-0.54	54.98	-0.54	0.45	16.87	2.38	1.05	55.82
Child Welfare Medicaid enrollment category	7.87	0.56	92.87	9.72	0.08	99.22	9.04	-3.95	56.34	6.58	2.70	58.91
Smoking during pregnancy: Yes	1.38	1.20	13.07	2.50	1.28	48.73	3.38	-1.03	69.47	4.09	1.20	70.67
Smoking during pregnancy: Unknown	-0.74	-0.33	54.69	-0.84	1.23	-46.34	-1.60	0.19	87.93	-3.92	0	99.94
Mother: Any previous live births	-24.40	-1.49	93.89	-23.81	-1.90	92.01	-24.43	-2.19	91.02	**-28.12**†	-3.76	86.62
Mother: Unknown number of previous live births	1.14	-0.33	70.93	-0.23	0.90	-288.26	-0.49	0.25	48.80	-2.04	-0.09	95.80
Short inter-pregnancy interval (6–17 months)	-11.69	-0.40	96.54	-10.07	0.20	97.99	-10.15	0.45	95.56	-9.57	0.45	95.31
Inter-pregnancy interval unknown	-6.63	-0.64	90.31	-3.91	0.04	98.93	-4.69	-0.69	85.23	-5.05	-0.02	99.59
Gender: male	0	0.22	<-500	1.43	-0.51	64.21	1.29	-0.96	25.41	-0.27	1.12	-320.21

Characteristic	1-year-olds			2-year-olds			3-year-olds			4-year-olds		
	SB before IPW	SB after IPW	ASB % change	SB before IPW	SB after IPW	ASB % change	SB before IPW	SB after IPW	ASB % change	SB before IPW	SB after IPW	ASB % change
Multiple birth	-13.24	-0.82	93.84	-10.62	-0.14	98.68	-3.18	0.19	94.16	-4.46	-0.92	79.27
Gestational age unknown	2.95	1.31	55.47	0.83	-0.90	-7.67	0.79	1.20	-52.20	-0.36	0.77	-114.95
Gestational age (in weeks)	-2.87	-1.31	54.56	-0.97	0.96	0.71	-0.85	-1.19	-40.20	0.43	-0.77	-77.55
Early birth (37 or 38 weeks)	-0.40	0.69	-70.89	-0.06	-0.12	-108.07	-1.12	-0.74	33.92	-2.15	1.36	36.51
Other preterm birth (33–36 weeks)	-5.13	0.22	95.73	-0.20	-0.34	-69.07	-0.84	0.86	-2.02	-1.75	-1.70	3.25
Very preterm birth (< 32 weeks)	3.46	-1.08	68.75	6.48	-2.10	67.57	4.78	-1.03	78.37	1.21	0.17	86.32
Birthweight (in g)	0.20	0.47	-130.34	-1.19	1.26	-5.77	-3.68	-0.47	87.38	-0.05	-0.70	<-500
Low birthweight (1,500–2,499 g)	-2.80	0.22	92.24	0.31	0.13	57.87	-0.23	-1.09	-370.41	-0.18	-0.54	-194.45
Normal birthweight (2,500–3,999 g)	0.44	-0.19	57.54	-2.12	0.80	62.30	-0.97	1.41	-45.23	-0.58	0.67	-16.42
High birthweight (4,000g or more)	0.70	0.51	27.39	0.40	0.26	34.54	-1.07	-0.81	23.77	0.80	-0.58	27.27
Medicaid Managed Care beneficiary	-14.81	0.18	98.75	-20.61	-0.83	95.95	-18.13	-0.16	99.10	-18.08	-0.99	94.50
Quarter of birth: 2nd quarter	3.65	1.34	63.31	1.26	0.61	51.64	-1.24	1.65	-33.15	0.63	1.33	-110.91
Quarter of birth: 3rd quarter	-5.76	0.55	90.38	-2.41	0.78	67.51	1.20	0.15	87.83	-1.64	0.57	65.07
Quarter of birth: 4th quarter	-8.44	-0.86	89.84	-5.41	-0.33	93.91	-1.18	-1.59	-34.88	3.31	-2.09	36.79

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on child Medicaid beneficiaries continuously enrolled from January to December 2010 linked with a Vital Records birth certificate.

This table examines the improvement in balance between the WIC participants and nonparticipants achieved through IPW on individual characteristics included as predictors in the propensity score model. Child characteristics are defined in Chapter IV, Table IV.4. Standardize biases are presented as the percentage of one standard deviation, and calculated before IPW, as well as after IPW. The third column for each age cohort is the percentage reduction in the ASB achieved through IPW. The propensity score model included gestational age and the full set of covariates shown in Chapter IV, Table IV.4.

† ASB is larger than 25 percent of one standard deviation.

ASB = absolute value of SB; FPL = Federal poverty level; IPW = inverse probability weighting; SB = standardized bias; SNAP = Supplemental Nutrition Assistance Program; TANF = Temporary Assistance for Needy Families; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table D.OK.5. Comparisons of child characteristics for WIC participants and nonparticipants in the children's analysis, before and after inverse probability weighting, by age cohort

Characteristic	1-year-olds			2-year-olds			3-year-olds			4-year-olds		
	SB before IPW	SB after IPW	ASB % change	SB before IPW	SB after IPW	ASB % change	SB before IPW	SB after IPW	ASB % change	SB before IPW	SB after IPW	ASB % change
Mother's age at child's birth: ≤ 17 years	2.39	0.08	96.50	7.10	-1.09	84.67	9.02	0.87	90.31	7.96	-0.32	96.03
Mother's age at child's birth: 18 or 19 years	-3.70	-0.90	75.70	5.73	-0.17	97.00	6.20	-1.46	76.41	5.53	-1.08	80.46
Mother's age at child's birth: ≥ 35 years	8.05	2.51	68.83	0.52	1.59	-204.33	1.74	1.04	40.66	0.49	-0.58	-18.01
Mother's race/ethnicity: Hispanic	**39.03**†	1.81	95.36	**39.59**†	0.72	98.19	**36.57**†	1.54	95.78	**39.78**†	-0.17	99.58
Mother's race/ethnicity: Black non-Hispanic	-1.55	0.03	97.81	-0.17	-1.14	-564.75	0.04	-0.30	-687.02	-2.22	-0.19	91.58
Mother's race/ethnicity: American Indian or Alaska Native	-15.77	0.21	98.68	-19.06	-0.08	99.56	-15.68	0.10	99.34	-14.41	0.13	99.10
Mother's race/ethnicity: Asian or Pacific Islander	-0.88	-0.61	30.47	-1.74	-0.23	86.77	-1.98	-0.09	95.40	-3.23	0.18	94.43
Mother's race/ethnicity: Other or multiple races	-8.18	-0.04	99.54	-1.97	-0.09	95.26	-1.77	0.07	95.97	0.17	-0.08	54.09
Mother married	1.99	0.92	53.76	-2.75	1.73	37.08	-5.96	0.63	89.50	-3.53	2.30	34.97
Mother's education: Less than high school	18.06	1.82	89.91	18.97	2.79	85.31	20.00	2.28	88.60	17.33	0.82	95.28
Mother's education: Some college credit but no degree	-13.79	-0.87	93.66	-6.76	-1.41	79.16	-12.20	-1.55	87.31	-13.87	-1.26	90.93
Mother's education: College degree	-6.64	-0.54	91.92	-9.99	0.53	94.69	-7.44	0.09	98.86	-10.44	-0.84	91.94
Mother's education: Unknown	0.17	0.77	-345.57	2.61	-0.39	85.18	0.96	-0.87	9.61	-1.96	-0.26	86.69
Rural residence	-13.66	-1.94	85.83	-12.49	-1.38	88.97	-13.18	-1.84	86.05	-7.93	-2.44	69.29
Rural residence unknown	-1.86	0.59	68.08	-1.62	0.14	91.23	-3.32	0.02	99.53	-7.54	0.12	98.45
Family income: $0	-5.48	-0.85	84.54	1.63	-2.58	-58.51	-0.01	-1.08	-7329	-2.20	-1.45	34.00
Family income: > 100% FPL	4.68	0.28	93.94	-0.61	0.26	57.40	-1.80	0.17	90.35	-6.25	0.54	91.39
Family income as % FPL	7.65	0.72	90.57	1.42	2.63	-84.99	1.97	0.96	51.22	-1.56	1.09	30.40
Family income as % FPL * (income > 100% FPL)	3.91	0.39	90.08	-1.54	0.46	70.00	-2.74	0.32	88.27	-6.87	0.34	95.04
TANF participation	1.38	-0.63	54.17	1.81	-1.22	32.38	4.44	0.08	98.26	1.90	-0.63	66.62
Child's enrollment in Medicaid on the basis of aged, blind, and/or disabled eligibility	-1.78	0.41	77.12	0.76	0.37	51.92	-0.29	0.57	-97.26	0.24	-0.88	-269.18
Child Welfare Medicaid enrollment category	-2.62	-1.30	50.27	-1.19	-3.18	-167.54	-0.45	-2.20	-385.42	2.53	-2.25	11.16
Smoking during pregnancy: Yes	-5.75	-1.73	69.94	-5.50	-1.29	76.53	-6.65	-1.84	72.37	-7.70	-1.58	79.44
Smoking during pregnancy: Unknown	-3.85	0.85	78.01	-0.48	-0.95	-96.01	-2.57	-0.04	98.42	-0.74	0.32	56.52
Mother: Any previous live births	-6.67	1.52	77.16	-13.91	0.43	96.94	-13.55	0.38	97.18	-13.61	1.53	88.74
Short inter-pregnancy interval (6–17 months)	-9.07	-0.65	92.84	-8.65	-0.68	92.12	-8.79	-1.25	85.81	-9.05	-0.31	96.59
Inter-pregnancy interval unknown	-0.92	-0.50	45.21	1.42	-1.49	-5.49	2.30	0.73	68.46	-2.33	0.26	88.78
Gender: male	0.67	-0.07	90.07	-0.46	-1.05	-127.30	0.97	-2.39	-148.02	-0.58	-0.81	-39.44
Multiple birth	0.39	-0.57	-46.03	0.19	-0.76	-302.83	3.35	0.74	77.95	-1.14	-1.14	0.21
Gestational age unknown	-2.38	-0.37	84.61	0.65	-2.02	-210.12	-1.24	0.49	60.05	-1.70	0.17	89.88

Characteristic	1-year-olds			2-year-olds			3-year-olds			4-year-olds		
	SB before IPW	SB after IPW	ASB % change	SB before IPW	SB after IPW	ASB % change	SB before IPW	SB after IPW	ASB % change	SB before IPW	SB after IPW	ASB % change
Gestational age (in weeks)	2.59	0.39	84.92	-0.35	2.07	-500.99	1.33	-0.51	61.4	1.82	-0.16	91.01
Early birth (37 or 38 weeks)	-6.13	0.48	92.17	-5.46	-0.11	97.98	-4.89	-0.90	81.61	-6.23	0.10	98.43
Other preterm birth (33–36 weeks)	-3.02	-0.39	86.95	-3.30	-2.23	32.47	-1.48	0.73	50.68	-1.27	-1.28	-0.87
Very preterm birth (< 32 weeks)	2.54	-0.23	91.09	2.16	-0.02	99.25	2.88	0.24	91.57	0.77	0.51	33.92
Birthweight (in g)	1.45	1.01	30.21	1.32	0.65	51.06	1.31	-0.66	49.76	1.00	0.61	39.31
Low birthweight (1,500–2,499 g)	-0.93	-0.11	88.11	-2.65	-0.71	73.34	-0.72	1.27	-76.26	-0.10	-1.78	-1774
Normal birthweight (2,500–3,999 g)	-1.29	0.53	58.39	0.37	-0.51	-39.36	-2.38	-0.71	70.27	0.04	0.65	-1642
High birthweight (4,000g or more)	1.63	-0.03	98.34	0.82	1.97	-140.76	3.55	-0.23	93.56	-0.41	0.47	-15.25
Quarter of birth: 2nd quarter	1.73	-0.57	67.14	4.57	0.04	99.13	-0.37	-1.00	-167.26	-3.74	0.81	78.35
Quarter of birth: 3rd quarter	-3.58	0.31	91.43	-2.85	0.33	88.36	-2.82	-0.28	90.22	-0.87	0	99.58
Quarter of birth: 4th quarter	-9.89	-0.11	98.86	-2.44	-1.17	51.90	-1.61	0.26	84.08	3.01	-1.17	61.10

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on child Medicaid beneficiaries continuously enrolled from January to December 2010 linked with a Vital Records birth certificate.

This table examines the improvement in balance between the WIC participants and nonparticipants achieved through IPW on individual characteristics included as predictors in the propensity score model. Child characteristics are defined in Chapter IV, Table IV.4. Standardize biases are presented as the percentage of one standard deviation, and calculated before IPW, as well as after IPW. The third column for each age cohort is the percentage reduction in the ASB achieved through IPW. The propensity score model included gestational age and the full set of covariates shown in Chapter IV, Table IV.4.

† ASB is larger than 25 percent of one standard deviation.

ASB = absolute value of SB; FPL = Federal poverty level; IPW = inverse probability weighting; SB = standardized bias; TANF = Temporary Assistance for Needy Families; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table D.MO.6. Summary measures of balance on child characteristics for WIC participants and nonparticipants in the children's analysis, before and after inverse probability weighting, by age cohort

		Mean ASB across covariates[a]	Logit model[b]			Omnibus test[c]	
			Pseudo R^2	chi-squared	*p*-value	chi-squared	*p*-value
1-year-olds	Before IPW	6.10	0.05	1,636	0.00	1,778	0.00
	After IPW	0.69	0.00	17.4	1.00	11.0	1.00
2-year-olds	Before IPW	5.92	0.05	1,444	0.00	1,616	0.00
	After IPW	0.70	0.00	25.7	0.99	13.1	1.00
3-year-olds	Before IPW	6.22	0.04	1,219	0.00	1,411	0.00
	After IPW	0.95	0.00	42.7	0.53	18.7	1.00
4-year-olds	Before IPW	6.14	0.05	1,173	0.00	1,370	0.00
	After IPW	1.13	0.00	51.4	0.21	26.5	0.98

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on child Medicaid beneficiaries continuously enrolled from January to December 2010 linked with a Vital Records birth certificate.

This table examines the improvement in balance between the WIC participants and nonparticipants achieved through IPW on individual characteristics included as predictors in the propensity score model.

[a] This measure is the mean of the absolute values of the SBs in column (6) in Table D.MO.5.

[b] This measure of covariate balance involves examining the goodness of fit of the propensity score regression before and after matching by reestimating the propensity score model with the matched sample. Before IPW, the variables in the model predict WIC participation, as would be expected given that the variables were selected in part for their ability to predict participation. A low pseudo-R^2 and/or failure to reject the hypothesis that the variables do not (jointly) predict participation using a log-likelihood ratio test, obtained with the matched sample, would indicate success of IPW in balancing the characteristics of the WIC participants and the matched comparison group. That is, if the covariates in the model no longer predict participation after IPW, the WIC participants and nonparticipants do not differ statistically on those characteristics.

[c] This test checks covariate balance between WIC beneficiaries and the matched comparison group of nonparticipants using a single "omnibus" test statistic. The omnibus test is based on the t-tests for the difference in means between the two groups across the set of covariates in Table D.MO.5. After performing each t-test (using a linear regression of the covariate on a WIC participation dummy), the estimation results—parameter estimates and associated covariance matrices—are combined into one parameter vector and simultaneous covariance matrix of the sandwich/robust type. After estimating the covariance matrix of the multivariate normal distribution of the estimators of the models, the omnibus test checks that the WIC participation dummies are jointly equal to zero. The advantage of the omnibus test is that it generates a single probability statement through one *p*-value capturing whether the groups differ statistically across all of the variables as a whole, and accounts for correlations across characteristics.

ASB = absolute value of SB; IPW = inverse probability weighting; SB = standardized bias; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table D.OK.6. Summary measures of balance on child characteristics for WIC participants and nonparticipants in the children's analysis, before and after inverse probability weighting, by age cohort

		Mean ASB across covariates[a]	Logit model[b]			Omnibus test[c]	
			Pseudo R^2	chi-squared	*p*-value	chi-squared	*p*-value
1-year-olds	Before IPW	5.55	0.04	871	0.00	992	0.00
	After IPW	0.70	0.00	13.2	1.00	8.9	1.00
2-year-olds	Before IPW	4.82	0.04	700	0.00	820	0.00
	After IPW	1.02	0.00	27.6	0.95	15.7	1.00
3-year-olds	Before IPW	5.13	0.03	592	0.00	689	0.00
	After IPW	0.80	0.00	14.7	1.00	8.9	1.00
4-year-olds	Before IPW	5.22	0.04	571	0.00	680	0.00
	After IPW	0.78	0.00	14.5	1.00	8.4	1.00

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on child Medicaid beneficiaries continuously enrolled from January to December 2010 linked with a Vital Records birth certificate.

This table examines the improvement in balance between the WIC participants and nonparticipants achieved through IPW on individual characteristics included as predictors in the propensity score model.

[a] This measure is the mean of the absolute values of the SBs in column (6) in Table D.OK.5.

[b] This measure of covariate balance involves examining the goodness of fit of the propensity score regression before and after matching by reestimating the propensity score model with the matched sample. Before IPW, the variables in the model predict WIC participation, as would be expected given that the variables were selected in part for their ability to predict participation. A low pseudo-R^2 and/or failure to reject the hypothesis that the variables do not (jointly) predict participation using a log-likelihood ratio test, obtained with the matched sample, would indicate success of IPW in balancing the characteristics of the WIC participants and the matched comparison group. That is, if the covariates in the model no longer predict participation after IPW, the WIC participants and nonparticipants do not differ statistically on those characteristics.

[c] This test checks covariate balance between WIC beneficiaries and the matched comparison group of nonparticipants using a single "omnibus" test statistic. The omnibus test is based on the t-tests for the difference in means between the two groups across the set of covariates in Table D.OK.5. After performing each t-test (using a linear regression of the covariate on a WIC participation dummy), the estimation results—parameter estimates and associated covariance matrices—are combined into one parameter vector and simultaneous covariance matrix of the sandwich/robust type. After estimating the covariance matrix of the multivariate normal distribution of the estimators of the models, the omnibus test checks that the WIC participation dummies are jointly equal to zero. The advantage of the omnibus test is that it generates a single probability statement through one *p*-value capturing whether the groups differ statistically across all of the variables as a whole, and accounts for correlations across characteristics.

ASB = absolute value of SB; IPW = inverse probability weighting; SB = standardized bias; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

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APPENDIX E

SUPPLEMENTARY TABLES FOR THE PRENATAL ANALYSIS

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Table E.MO.1. Comparison of the proportion of pregnant women participating in WIC based on three different measures of WIC participation

Participation in WIC as measured by food instrument redemption	Total N	Participation in WIC as measured by WIC certification		Participation in WIC as measured by self-reported status on birth certificate	
		Participated N (row %)	Did not participate N (row %)	Participated N (row %)	Did not participate[a] N (row %)
Participated	26,703	26,703 (100.0)	0	25,991 (97.3)	712 (2.7)
Participation began in first trimester	11,884	11,884 (100.0)	0	11,568 (97.3)	316 (2.7)
Participation began in second trimester	9,939	9,939 (100.0)	0	9,653 (97.1)	286 (2.7)
Participation began in third trimester	4,880	4,880 (100.0)	0	4,770 (97.7)	110 (2.3)
Did not participate	11,134	762 (6.8)	10,372 (93.2)	3,463 (31.1)	7,671 (68.9)
Sensitivity		100.0%		97.3%	
Specificity		93.2%		68.9%	
Positive predictive value		97.2%		88.2%	
Negative predictive value		100.0%		91.5%	
Accuracy		98.0%		89.0%	

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. Row percentages (in parentheses) may not total 100 percent because of rounding.

Treating the food instrument–based WIC participation measure as a benchmark, the sensitivity is the percentage of actual participants identified as a "participant" with the other measure(s). The specificity is the percentage of actual nonparticipant identified as a "nonparticipant" with the other measure(s). The positive predicted value is the percentage of women identified as "participants" who actually are participants. The negative predicted value is the percentage of women identified as "nonparticipants" who actually are nonparticipants. The accuracy is the percentage of all observations where WIC participation is correctly measured. Note that this table indicates the self-reported WIC participation measure on the birth certificate has higher sensitivity, but lower specificity, than was found in an unpublished report by Watson and Sappenfield (2010).

[a] Includes birth certificates when WIC participation was missing.

N = number of mothers; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.OK.1. Comparison of the proportion of pregnant women participating in WIC based on three different measures of WIC participation

Participation in WIC as measured by food instrument redemption	Total N	Participation in WIC as measured by WIC certification		Participation in WIC as measured by self-reported status on birth certificate	
		Participated N (row %)	Did not participate N (row %)	Participated N (row %)	Did not participate[a] N (row %)
Participated	22,537	22,537 (100.0)	0	21,407 (95.0)	1,130 (5.0)
Participation began in first trimester	9,825	9,825 (100.0)	0	9,349 (95.2)	476 (4.8)
Participation began in second trimester	8,656	8,656 (100.0)	0	8,248 (95.3)	408 (4.7)
Participation began in third trimester	4,056	4,056 (100.0)	0	3,810 (93.9)	246 (6.1)
Did not participate	8,145	624 (7.7)	7,521 (92.3)	2,286 (28.1)	5,859 (71.9)
Sensitivity		100.0%		95.0%	
Specificity		92.3%		71.9%	
Positive predictive value		97.3%		90.4%	
Negative predictive value		100.0%		83.8%	
Accuracy		98.0%		88.9%	

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate. Row percentages (in parentheses) may not total 100 percent because of rounding.

Treating the food instrument–-based WIC participation measure as a benchmark, the sensitivity is the percentage of actual participants identified as a "participant" with the other measure(s). The specificity is the percentage of actual nonparticipant identified as a "nonparticipant" with the other measure(s). The positive predicted value is the percentage of women identified as "participants" who actually are participants. The negative predicted value is the percentage of women identified as "nonparticipants" who actually are nonparticipants. The accuracy is the percentage of all observations where WIC participation is correctly measured. Note that this table indicates the self-reported WIC participation measure on the birth certificate has higher sensitivity, but lower specificity, than was found in an unpublished report by Watson and Sappenfield (2010).

[a] Includes birth certificates when WIC participation was missing.

N = number of mothers; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.2. Exploratory measures of health care utilization and Medicaid costs for the prenatal analysis

Construct	Measure	Definition
Mother's health care utilization during pregnancy and delivery	Number of office visits	Number of office visits during prenatal period and delivery (based on CMCS 2013, measures 16–17)
	Number of emergency department visits	Number of emergency department visits that did not result in an inpatient admission during prenatal period (and delivery)
	Number of hospitalizations	Number of hospitalizations during prenatal period and delivery
	Number of days in a hospital	Number of days in hospital during prenatal period and delivery[a]
	Length of hospital stay for delivery	Length of stay for hospitalization for delivery
	Any ICU admission at delivery	Binary indicator of ICU admission during hospitalization for delivery
	Number of days in an ICU at delivery	Number of days in ICU during hospitalization for delivery[a]
Mother's health care utilization during postpartum period (through 60 days)	Postpartum care visit	Binary indicator of postpartum office visit 21–56 days after delivery (based on CMCS 2013, measure 26)
	Number of office visits	Number of office visits in the postpartum period through 60 days (based on CMCS 2013, measures 16–17)
	Number of emergency department visits	Number of emergency department visits that did not result in an inpatient admission in the postpartum period through 60 days
	Number of hospitalizations (postpartum)	Number of hospitalizations in the postpartum period through 60 days
	Number of days in a hospital (postpartum)	Number of days in hospital in the postpartum period through 60 days[a]
Infant's health care utilization during postpartum period (through 60 days)	Number of hospitalizations	Number of hospitalizations through 60 days
	Length of hospital stay for birth	Number of days in hospital for the initial birth stay through 60 days[a]
	Number of days in a hospital (total)	Number of days in hospital for initial birth stay through 60 days[a]
	Hospitalizations with a NICU admission	Binary indicator of NICU admission (NICU Levels 3 or 4) in first 60 days
	Hospitalizations with Level 3 NICU admission: number of days	Number of unique days in the hospital associated with one or more inpatient claims that included Level 3 NICU revenue center charge codes through 60 days[a]
	Hospitalizations with Level 4 NICU admission: number of days	Number of unique days in the hospital associated with one or more inpatient claims that included Level 4 NICU revenue center charge codes through 60 days[a]
	Number of emergency department visits	Number of emergency department visits that did not result in an inpatient admission through 60 days

Construct	Measure	Definition
Infant's health care utilization during postpartum period (through 60 days) *(continued)*	Number of office visits (well- or sick-infant)	Number of office visits through 60 days
	Number of well-infant office visits	Number of well-infant office visits through 60 days; well-infant office visits includes EPSDT and other preventative care (based on CMCS 2012, measure 10)
	Number of EPSDT visits	EPSDT visits through 60 days; EPSDT visits were identified with codes provided by the Oklahoma Medicaid agency
	Number of sick-infant office visits	Other office visits through 60 days; measure includes all office visits not categorized as well-infant visits
Medicaid costs for the infant	Medicaid costs for newborn (only) through 60 days after birth ($)	Continuous measure of costs for newborns at birth and through 60 days after birth (from fee-for-service Medicaid claims)[a]
Medicaid costs for the mother	Medicaid costs for mother (only) for pregnancy, delivery, and through 60 days postpartum ($)	Continuous measure of costs for mothers' prenatal care, labor and delivery, and other medical care through 60 days postpartum (from fee-for-service Medicaid claims)[a]
	Medicaid costs for mother for pregnancy ($)	Continuous measure of costs for mothers' claims during the prenatal period (from fee-for-service Medicaid claims)[a]
	Medicaid costs for mother for delivery and postpartum period through 60 days ($)	Continuous measure of costs for mothers' labor and delivery and other medical care through 60 days postpartum (from fee-for-service Medicaid claims)[a]
Inpatient (hospital) Medicaid costs	Costs paid for infants' inpatient claims through 60 days after birth ($)	Continuous measure of costs for inpatient (hospital) claims for newborns at birth and through 60 days after birth (from fee-for-service Medicaid claims)[a]
	Costs paid for mothers' inpatient claims during prenatal period ($)	Continuous measure of costs for mothers' inpatient (hospital) claims during the prenatal period (from fee-for-service Medicaid claims)[a]
	Costs paid for mothers' inpatient claims for delivery and postpartum period through 60 days ($)	Continuous measure of costs for mothers' inpatient (hospital) claims during the delivery and after the delivery through 60 days postpartum (from fee-for-service Medicaid claims)[a]
Other (non-inpatient) Medicaid costs	Costs paid for infants' other (non-inpatient) claims through 60 days after birth ($)	Continuous measure of costs for other (non-inpatient) claims for newborns at birth and through 60 days after birth (from fee-for-service Medicaid claims)[a]
	Costs paid for mothers' other (non-inpatient) claims during prenatal period ($)	Continuous measure of costs for mothers' other (non-inpatient) claims during the prenatal period (from fee-for-service Medicaid claims)[a]
	Costs paid for mothers' other (non-inpatient) claims for delivery and postpartum period through 60 days ($)	Continuous measure of costs for other (non-inpatient) claims during the delivery and after the delivery through 60 days postpartum (from fee-for-service Medicaid claims)[a]

Notes: All health care utilization measures listed in this table were constructed from the Medicaid files. Table E.3 provides additional details on the construction of outcome measures from the Medicaid files.

[a] In the primary specification, for Medicaid claims that started within the 60-day period after birth but extended beyond the 60-day period, the number of days in a hospital or ICU were prorated according to the proportion of the service period that occurred within the 60-day postpartum period. In some cases, it is difficult to categorize a particular claim as occurring during the prenatal/delivery period or during the postpartum period. However, these measures will, in combination, measure all health care utilization in the two periods. That is, there may be measurement error for the two measures separately, but the sum of the two measures will be accurate. All infant claims were assigned to the postpartum period.

CMCS = Center for Medicaid and CHIP Services; EPSDT = Early and Periodic Screening, Diagnostic, and Treatment; ICU = intensive care unit; NICU = neonatal intensive care unit.

Table E.3. Additional details on the construction of outcome variables from Medicaid claims for the prenatal analysis

Construct or classification	Definition
Medicaid claims	Claims data included claims paid by Medicaid and encounter claims. In Missouri, void claims were removed from the file. In Oklahoma, the Medicaid agency provided final action claims.
Managed care claims	In Missouri, managed care claims were identified based on the first two digits of the ICN number. In Oklahoma, there were not any managed claims.
Prenatal and postpartum periods	In the prenatal analyses, the prenatal and postpartum periods generally refer to the 228 days before the infant's date of birth and the 60 days following the infant's date of birth, respectively.
Claim type	Using state-specific codes for the claim type field, claims were classified into six mutually exclusive categories: (1) inpatient claims, (2) physician and other medical/carrier claims (excluding dental claims), (3) outpatient claims, (4) prescription drug claims, (5) dental claims (included all claims identified as described below), and (6) other claims.
Type of provider	Physician; obstetrics and gynecology (OB/GYN); midwife; PA, NP, and RN; birth center; and clinic; and public clinic claims were identified using provider type or billing provider specialty using state-specific codes.
Dental claims	Dental claims were identified using claim type, provider type, or provider specialty (state-specific codes), or identified by a CPT/CDT procedure code beginning with "D" or ICD-9 diagnosis 520.x or 521.x or revenue code of 0512. For sensitivity analyses, we created subcategories of preventive dental services (CPT/CDT codes D1000-D1999) or dental treatment services (CPT/CDT codes D2000-D9999), as well as measures based on CPT/CDT codes alone (without using claim type, provider type, or provider specialty codes).
Medicaid costs	Measures of the total cost paid by Medicaid—either for all claims or claims within a particular category (for example, inpatient claims)—were calculated as the costs recorded on the header row when a claim had header row, or the sum of the costs recorded on individual claim lines when the claim did not have a header row. In Missouri, we did not include any costs for managed care encounter claims in the totals. The main measures of Medicaid costs prorated claims that have start/end dates partially in the prenatal and postpartum periods. Costs for claims were prorated using the methods from the WIC-Medicaid I study, as documented in Schore et al. 1991. In sensitivity analyses, measures of postpartum Medicaid costs were calculated that included prorate costs—all costs for a claim were included, as long as the claim started in the postpartum period.
Hospitalizations	Hospital claims included inpatient claims plus other claims identified as hospital stays with provider type or billing provider specialty (state-specific codes). Measures of inpatient (hospital) use were constructed from a file with one row per discharge (cases with transfers between hospitals count as one discharge, regardless of the number of hospitals). For most discharges, the number of unique days in the hospital was equal to the discharge date minus the admission date plus one. Transfers were identified using state-specific patient discharge status codes. Measures for the number of days hospitalized were prorated similarly to measures of Medicaid costs (see above). In sensitivity analyses, these measures were calculated where the number of days was not prorated (including all days for admissions with a start date in the relevant time period).

Construct or classification	Definition
Emergency room visits	Outpatient claims were flagged as emergency department visits if they had one of the following codes: Revenue Center equal to 045X (that is, 0450 to 0459) or 0981, or CPT/HCPCS procedure code = 99281 to 99285. (In Missouri, state-specific codes were also used to flag emergency room claims.) Emergency room visits were excluded if they resulted in an inpatient hospitalization or an observation stay (beginning on the same day or the next day). Sensitivity analyses were conducted with relaxed criteria, also including claims with the following CPT/HCPCS procedure codes: 99026 to 99027, 99175, 99288 to 99290, or G0380 to G0384.
Prenatal care	Prenatal care claims were identified according to the procedure in CMCS (2012). Claims are identified based on the CPT/HCPCS procedure code, ICD-9 diagnosis code, or ICD-9 procedure code, type of provider (OB/GYN, midwife, physician, clinic [any type], birth center, PA/NP/RN, prenatal services), and the date of the claim in relation to the infant's date of birth. The claims data used for WM-II do not include LOINC fields. We identified prenatal care for all women in the WM-II sample, not only those who met the denominator restrictions in CMCS (2012). Prenatal care from a public clinic (a control/matching variable) identified women for whom at least one prenatal care claim was from a public clinic.
Office visits for mothers	Claims were flagged as an office visit if they had one of the following CPT/HCPCS procedure codes: 99201-99205, 99212-99215, 99241-99245, 99381-99387, or 99391-99397. When counting the number of office visits, claims on the same day were counted as a single visit. Claims were limited to outpatient and medical claims and excluded claim lines with lab, imaging, DME, and ambulance BETOS codes.
Postpartum care	Postpartum care claims were identified according to the procedure in CMCS (2013). Claims are identified based on the CPT/HCPCS procedure code, ICD-9 diagnosis code, or ICD-9 procedure code or revenue code and the date of the claim in relation to the infant's date of birth (between 21 and 56 days after delivery). Postpartum care was identified for all women in the WM-II sample, not only those who met the denominator restrictions in CMCS (2013).
NICU Level 3	NICU Level 3 claims were identified as inpatient claims with revenue code 0173 (Nursery-newborn-level III)
NICU Level 4	NICU Level 4 claims were identified as inpatient claims with revenue code 0174 (Nursery-newborn-level IV / intensive care) or 0175 (Nursery-neonatal ICU -- inactive code)
Office visits for infants	Office visits for infants were defined as claims flagged as well-infant visits (see next row) or with a physician provider type (see above) or with CPT/HCPCS procedure codes 99201-99205, 99212-99215, 99241-99245, 99381-99387, or 99391-99397.
Well-infant visits	Well-infant visits were defined as claims flagged as an EPSDT visit (see next row) or with one or more of the following codes: CPT/HCPCS procedure codes 99381, 99391, 99432, 99461 or ICD-9 diagnosis codes V20.2, V20.3, V70.0, V70.3, V70.5, V70.6, V70.8, V70.9.
EPSDT visits	EPSDT visits were defined using state-specific coding rules (based on documentation received from each State).
Sick-infant (other) office visits	Office visits not flagged as well-infant visits (see above).

BETOS = Berenson-Eggers Type of Service (from CMS Public Use File [2011]); CDT = Code on Dental Procedures and Nomenclature; CPT = current procedural terminology; DME = durable medical equipment; HCPCS = healthcare common procedure coding system; ICD-9 = International Conference for the Ninth Revision of the International Classification of Diseases; ICN = internal control number; NP = nurse practitioner; PA = physician assistant; RN = registered nurse.

Table E.MO.4. Total number of mother–infant dyads and the number of dyads with nonmissing data for each outcome, by trimester of WIC enrollment

Outcomes	Number of mother–infant dyads where the outcome measure is applicable (row percentage in parentheses)a						Number of mother–infant dyads with nonmissing data for each outcome (percentage of mother–infant dyads in parentheses)					
	WIC participants						WIC participants					
	Trimester WIC participation began			All participants	Non-participants	Total	Trimester WIC participation began			All participants	Non-participants	Total
	First	Second	Third				First	Second	Third			
Birth outcomes												
Gestational age and preterm/very preterm birth rates	11,884 (31.4)	9,939 (26.3)	4,880 (12.9)	26,703 (70.6)	11,134 (29.4)	37,837 (100.0)	11,884 (100.0)	9,939 (100.0)	4,880 (100.0)	26,703 (100.0)	11,134 (100.0)	37,837 (100.0)
All birthweight and fetal growth outcomes	11,884 (31.4)	9,939 (26.3)	4,880 (12.9)	26,703 (70.6)	11,134 (29.4)	37,837 (100.0)	11,854 (99.7)	9,914 (99.7)	4,870 (99.8)	26,638 (99.8)	11,095 (99.6)	37,733 (99.7)
All infant mortality outcomes	11,884 (31.4)	9,939 (26.3)	4,880 (12.9)	26,703 (70.6)	11,134 (29.4)	37,837 (100.0)	11,884 (100.0)	9,939 (100.0)	4,880 (100.0)	26,703 (100.0)	11,134 (100.0)	37,837 (100.0)
Maternal behaviors												
Breastfeeding at discharge	11,884 (31.4)	9,939 (26.3)	4,880 (12.9)	26,703 (70.6)	11,134 (29.4)	37,837 (100.0)	11,495 (92.3)	9,510 (92.1)	4,624 (92.7)	25,629 (92.3)	10,189 (93.0)	35,818 (92.5)
Smoked during pregnancy	11,884 (31.4)	9,939 (26.3)	4,880 (12.9)	26,703 (70.6)	11,134 (29.4)	37,837 (100.0)	11,754 (98.9)	9,826 (98.9)	4,819 (98.8)	26,399 (98.9)	10,991 (98.7)	22,745 (98.8)
Any smoking during third trimester and high/medium/low smoking level	11,884 (51.6)	0[b]	0[b]	11,884 (51.6)	11,134 (48.4)	23,018 (100.0)	11,754 (98.9)	n.a.	n.a.	11,754 (98.9)	10,991 (98.7)	22,745 (98.8)
Received adequate prenatal care (Kessner Index)	11,884 (31.4)	9,939 (26.3)	4,880 (12.9)	26,703 (70.6)	11,134 (29.4)	37,837 (100.0)	11,495 (92.3)	9,510 (92.1)	4,624 (92.7)	25,629 (92.3)	10,189 (93.0)	35,818 (92.5)
Received adequate prenatal care (APNCU Index)	11,884 (31.4)	9,939 (26.3)	4,880 (12.9)	26,703 (70.6)	11,134 (29.4)	37,837 (100.0)	10,981 (92.4)	9,099 (91.5)	4,444 (91.1)	24,524 (91.8)	9,751 (87.6)	34,275 (90.6)
Received adequate prenatal care (APNCU-M2 Index)	11,884 (31.4)	9,939 (26.3)	4,880 (12.9)	26,703 (70.6)	11,134 (29.4)	37,837 (100.0)	11,067 (93.1)	9,216 (92.7)	4,494 (92.1)	24,777 (92.8)	9,881 (88.7)	34,658 (91.6)
Any Medicaid-paid prenatal care[c]	11,782 (31.8)	9,795 (26.5)	4,792 (12.9)	26,369 (71.2)	10,650 (28.8)	37,019 (100.0)	11,782 (100.0)	9,795 (100.0)	4,792 (100.0)	26,369 (100.0)	10,650 (100.0)	37,019 (100.0)

Outcomes	Number of mother–infant dyads where the outcome measure is applicable (row percentage in parentheses)a						Number of mother–infant dyads with nonmissing data for each outcome (percentage of mother–infant dyads in parentheses)					
	WIC participants						WIC participants					
	Trimester WIC participation began			All participants	Non-participants	Total	Trimester WIC participation began			All participants	Non-participants	Total
	First	Second	Third				First	Second	Third			
Maternal health												
Weight gain during pregnancy	11,884 (31.4)	9,939 (26.3)	4,880 (12.9)	26,703 (70.6)	11,134 (29.4)	37,837 (100.0)	11,166 (94.0)	9,310 (93.7)	4,571 (93.7)	25,047 (93.8)	10,447 (93.8)	35,494 (93.8)
Gestational diabetes and hypertension	11,884 (31.4)	9,939 (26.3)	4,880 (12.9)	26,703 (70.6)	11,134 (29.4)	37,837 (100.0)	11,884 (100.0)	9,939 (100.0)	4,880 (100.0)	26,703 (100.0)	11,134 (100.0)	37,837 (100.0)
Indication of Cesarean section[c]	11,782 (31.8)	9,795 (26.5)	4,792 (12.9)	26,369 (71.2)	10,650 (28.8)	37,019 (100.0)	11,459 (97.3)	9,517 (97.2)	4,646 (97.0)	25,622 (97.2)	10,342 (97.1)	35,964 (97.2)
Medicaid costs												
All Medicaid cost outcomes[c]	5,376 (39.0)	3,438 (25.0)	1,507 (10.9)	10,321 (74.9)	3,458 (25.1)	13,779 (100.0)	5,376 (100.0)	3,438 (100.0)	1,507 (100.0)	10,321 (100.0)	3,458 (100.0)	13,779 (100.0)

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. Outcomes are defined in Table III.3. Row percentages (in parentheses) may not total 100 percent because of rounding.

[a] As mentioned in the text, the sample for this study was limited to observations where gestational age was nonmissing. For measures of Medicaid costs and mother's health care use constructed from the Medicaid files (including Medicaid-paid prenatal care and indication of Cesarean section), the sample was limited to mother–infant dyads with Medicaid data for the mother; for measures of Medicaid costs, infant Medicaid costs, and infant's health care use, the sample was limited to mother–infant dyads with Medicaid data for the infant. The analysis of Medicaid costs includes only fee-for-service recipients. Approximately 64 percent of Medicaid recipients in Missouri are enrolled in Medicaid managed care. Managed care claims in Missouri do not include information about actual costs of services.

[b] Measures were restricted to first-trimester WIC enrollees and nonparticipants (only).

[c] Medicaid claims-based measure.

APNCU = Adequacy of Prenatal Care Utilization; /WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

n.a. = not applicable.

Table E.OK.4. Total number of mother–infant dyads and the number of dyads with nonmissing data for each outcome, by trimester of WIC enrollment

Outcomes	Number of mother–infant dyads where the outcome measure is applicable (row percentage in parentheses)a						Number of mother–infant dyads with nonmissing data for each outcome (percentage of mother–infant dyads in parentheses)					
	WIC participants						WIC participants					
	Trimester WIC participation began			All participants	Non-participants	Total	Trimester WIC participation began			All participants	Non-participants	Total
	First	Second	Third				First	Second	Third			
Birth outcomes												
Gestational age and preterm/very preterm birth rates	9,825 (32.0)	8,656 (28.2)	4,056 (13.2)	22,537 (73.5)	8,145 (26.5)	30,682 (100.0)	9,825 (100.0)	8,656 (100.0)	4,056 (100.0)	22,537 (100.0)	8,145 (100.0)	30,682 (100.0)
All birthweight and fetal growth outcomes	9,825 (32.0)	8,656 (28.2)	4,056 (13.2)	22,537 (73.5)	8,145 (26.5)	30,682 (100.0)	9,819 (99.9)	8,652 (≈100.0)	4,055 (≈100.0)	22,526 (≈100.0)	8,138 (99.9)	30,664 (99.9)
All infant mortality outcomes	9,825 (32.0)	8,656 (28.2)	4,056 (13.2)	22,537 (73.5)	8,145 (26.5)	30,682 (100.0)	9,825 (100.0)	8,656 (100.0)	4,056 (100.0)	22,537 (100.0)	8,145 (100.0)	30,682 (100.0)
Maternal behaviors												
Breastfeeding at discharge	9,825 (32.0)	8,656 (28.2)	4,056 (13.2)	22,537 (73.5)	8,145 (26.5)	30,682 (100.0)	9,624 (98.0)	8,517 (98.4)	4,011 (98.9)	22,152 (98.3)	7,977 (97.9)	30,129 (98.2)
Smoked during pregnancy	9,825 (32.0)	8,656 (28.2)	4,056 (13.2)	22,537 (73.5)	8,145 (26.5)	30,682 (100.0)	9,145 (93.1)	8,126 (93.9)	3,786 (93.3)	21,057 (93.4)	7,624 (93.6)	28,681 (93.5)
Any smoking during third trimester and high/medium/low smoking level	9,825 (54.7)	0[b]	0[b]	9,825 (54.7)	8,145 (45.3)	17,970 (100.0)	9,332 (95.0)	n.a.	n.a.	9,332 (95.0)	7,806 (95.8)	17,138 (95.4)
Received adequate prenatal care (Kessner Index)	9,825 (32.0)	8,656 (28.2)	4,056 (13.2)	22,537 (73.5)	8,145 (26.5)	30,682 (100.0)	9,501 (96.7)	8,314 (96.0)	3,875 (95.5)	21,690 (96.2)	7,522 (92.4)	29,212 (95.2)
Received adequate prenatal care (APNCU Index)	9,825 (32.0)	8,656 (28.2)	4,056 (13.2)	22,537 (73.5)	8,145 (26.5)	30,682 (100.0)	9,317 (94.8)	8,150 (94.2)	3,815 (94.1)	21,282 (94.4)	7,413 (91.0)	28,695 (93.5)
Received adequate prenatal care (APNCU-M2 Index)	9,825 (32.0)	8,656 (28.2)	4,056 (13.2)	22,537 (73.5)	8,145 (26.5)	30,682 (100.0)	9,351 (95.2)	8,202 (94.8)	3,838 (94.6)	21,391 (94.9)	7,456 (91.5)	28,847 (94.0)
Any Medicaid-paid prenatal care[c]	7,958 (32.1)	7,195 (29.0)	3,387 (13.7)	18,540 (74.8)	6,261 (25.2)	24,801 (100.0)	7,958 (100.0)	7,195 (100.0)	3,387 (100.0)	18,540 (100.0)	6,261 (100.0)	24,801 (100.0)

Outcomes	Number of mother–infant dyads where the outcome measure is applicable (row percentage in parentheses)a						Number of mother–infant dyads with nonmissing data for each outcome (percentage of mother–infant dyads in parentheses)					
	WIC participants						WIC participants					
	Trimester WIC participation began			All participants	Non-participants	Total	Trimester WIC participation began			All participants	Non-participants	Total
	First	Second	Third				First	Second	Third			
Maternal health												
Weight gain during pregnancy	9,825 (32.0)	8,656 (28.2)	4,056 (13.2)	22,537 (73.5)	8,145 (26.5)	30,682 (100.0)	9,578 (97.5)	8,378 (96.8)	3,932 (96.9)	21,888 (97.1)	7,883 (96.8)	29,771 (97.0)
Gestational diabetes and hypertension	9,825 (32.0)	8,656 (28.2)	4,056 (13.2)	22,537 (73.5)	8,145 (26.5)	30,682 (100.0)	9,825 (100.0)	8,656 (100.0)	4,056 (100.0)	22,537 (100.0)	8,145 (100.0)	30,682 (100.0)
Indication of Cesarean section[c]	7,958 (32.1)	7,195 (29.0)	3,387 (13.7)	18,540 (74.8)	6,261 (25.2)	24,801 (100.0)	7,883 (99.1)	7,121 (99.0)	3,363 (99.3)	18,367 (99.1)	6,199 (99.0)	24,566 (99.1)
Medicaid costs												
All Medicaid cost outcomes[c]	8,070 (31.7)	7,348 (28.9)	3,464 (13.6)	18,882 (74.3)	6,537 (25.7)	25,419 (100.0)	8,070 (100.0)	7,348 (100.0)	3,464 (100.0)	18,882 (100.0)	6,537 (100.0)	25,419 (100.0)

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate. Outcomes are defined in Table III.3. Row percentages (in parentheses) may not total 100 percent because of rounding.

[a] As mentioned in the text, the sample for this study was limited to observations where gestational age was nonmissing. For measures of Medicaid costs and mother's health care use constructed from the Medicaid files (including Medicaid-paid prenatal care and indication of Cesarean section), the sample was limited to mother–infant dyads with Medicaid data for the mother; for measures of Medicaid costs, infant Medicaid costs, and infant's health care use, the sample was limited to mother–infant dyads with Medicaid data for the infant. The analysis of Medicaid costs excludes Native Americans. Oklahoma Medicaid did not provide cost data for Native Americans because many of these individuals receive care through the IHS, and IHS providers do not necessarily report all services and costs to Oklahoma Medicaid.

[b] Measures were restricted to first-trimester WIC enrollees and nonparticipants (only).

[c] Medicaid claims-based measure.

APNCU = Adequacy of Prenatal Care Utilization; IHS = Indian Health Service; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

n.a. = not applicable.

Table E.MO.5. Length of gestation and primary outcomes for prenatal WIC participants, by month of pregnancy in which WIC participation began, and nonparticipants

Outcome	WIC participants											
	By month of pregnancy in which WIC participation began											
	1st month	2nd month	3rd month	4th month	5th month	6th month	7th month	8th month	9th month+	All participants	Non-participants	Sample Size
Gestational age												
Gestational age (in weeks)	37.86	38.82	38.55	38.54	38.60	38.61	38.59	38.74	38.82	38.58	38.35	37,837
Preterm birth (%)	15.75	10.01	8.48	9.01	8.07	8.16	8.56	6.74	6.56	8.30	11.26	37,837
Birth outcomes												
Low birthweight (%)	8.66	8.12	7.92	8.24	6.76	7.47	8.73	6.75	4.69	7.45	9.81	37,733
Very low birthweight (%)	1.57	1.42	1.33	1.25	1.14	1.26	1.01	0.29	0.07	1.11	1.85	37,733
Small-for-gestational age (%)	11.81	10.79	12.15	11.00	10.71	11.06	11.05	12.04	11.47	11.25	10.49	37,729
Neonatal mortality (deaths per 1,000)	15.75	4.65	4.06	3.63	3.78	1.58	1.44	0.59	0.72	3.26	4.85	37,837
Maternal behaviors												
Breastfeeding at discharge (%)	55.75	59.29	60.23	61.75	59.75	59.75	58.23	57.29	56.66	59.62	58.62	34,997
Maternal health												
Had lower than recommended weight gain during pregnancy (%)	22.41	18.07	18.26	17.57	18.22	18.01	17.49	16.58	16.98	17.71	19.17	35,494
Had higher than recommended weight gain during pregnancy (%)	50.86	48.56	48.31	47.64	46.36	46.28	46.25	45.95	45.45	47.31	43.30	35,494

Outcome	WIC participants: By month of pregnancy in which WIC participation began: 1st month	2nd month	3rd month	4th month	5th month	6th month	7th month	8th month	9th month+	All participants	Non-participants	Sample Size
Medicaid costs												
Medicaid costs from birth through 60 days postpartum ($)[a]	5,429	7,034	6,959	6,916	6,341	6,589	6,544	5,882	5,347	6,676	7,143	13,779
Medicaid costs from the prenatal period through 60 days postpartum ($)[a]	9,440	10,875	10,429	10,296	9,592	9,667	9,626	8,843	8,145	10,073	9,948	13,779
Sample size[b]	**127**	**4,084**	**6,401**	**4,405**	**3,172**	**2,537**	**2,079**	**1,706**	**1,387**	**26,703**	**11,134**	**37,837**

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. Some observations were dropped, on a variable-by-variable basis, due to missing data.

Outcomes are defined in Table III.3. The low birthweight and very low birthweight outcome measures are binary indicators of birthweight fewer than 2,500 g and fewer than 1,500 g, respectively. The preterm birth outcome measure is a binary indicator of delivery at less than 37 weeks. Small-for-gestational age infants had birthweights below the 10th percentile for gestational age based on race/ethnicity- and gender-specific reference standards. Neonatal infant mortality includes infant deaths occurring fewer than 28 days after birth. Lower than [higher than] recommended weight gain during pregnancy are weight gains 10 percent or more below [above] the IOM recommendations.

[a] The analysis of Medicaid costs includes only fee-for-service recipients. Approximately 64 percent of Medicaid recipients in Missouri are enrolled in Medicaid managed care. Managed care claims in Missouri do not include information about actual costs of services.

[b] Sample size in this row includes all woman-infant dyads, including those for whom one or more outcome variables are missing or not applicable.

g = grams; IOM = Institute of Medicine (now referred to as the National Academies of Science, Engineering and Medicine); WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.OK.5. Length of gestation and primary outcomes for prenatal WIC participants, by month of pregnancy in which WIC participation began, and nonparticipants

Outcome	WIC participants											
	By month of pregnancy in which WIC participation began											
	1st month	2nd month	3rd month	4th month	5th month	6th month	7th month	8th month	9th month+	All participants	Non-participants	Sample Size
Gestational age												
Gestational age (in weeks)	37.22	38.15	38.33	38.43	38.38	38.46	38.46	38.53	38.63	38.39	38.15	30,682
Preterm birth (%)	19.88	11.49	9.64	9.26	9.98	9.60	8.95	8.43	7.39	9.44	12.09	30,682
Birth outcomes												
Low birthweight (%)	11.11	7.21	7.13	7.26	7.61	7.64	7.33	6.42	5.07	7.01	8.90	30,664
Very low birthweight (%)	2.92	1.04	1.41	1.07	1.17	0.96	0.81	0.07	0.17	1.00	1.90	30,664
Small-for-gestational age (%)	7.60	11.17	10.47	10.65	10.42	10.75	10.57	11.40	9.72	10.69	10.59	30,662
Neonatal mortality (deaths per 1,000)	11.70	2.98	4.39	4.42	3.64	3.66	1.73	2.76	0.00	3.42	4.42	30,682
Maternal behaviors												
Breastfeeding at discharge (%)	64.85	65.41	68.09	70.16	69.90	66.51	67.64	65.57	64.75	67.63	64.71	30,129
Maternal health												
Had lower than recommended weight gain during pregnancy (%)	20.83	19.70	19.95	20.32	21.62	22.05	20.94	21.57	23.19	20.73	24.10	29,771
Had higher than recommended weight gain during pregnancy (%)	45.24	44.15	43.83	42.65	41.44	41.60	39.26	37.64	39.03	42.19	38.37	29,771

Outcome	WIC participants: By month of pregnancy in which WIC participation began: 1st month	2nd month	3rd month	4th month	5th month	6th month	7th month	8th month	9th month+	All participants	Non-participants	Sample Size
Medicaid costs												
Medicaid costs from birth through 60 days postpartum ($)[a]	6,775	6,390	6,004	5,469	5,478	5,608	5,860	5,151	4,630	5,692	5,840	25,419
Medicaid costs from the prenatal period through 60 days postpartum ($)[a]	10,885	10,400	9,924	9,136	9,063	5,608	5,860	5,151	4,630	5,692	5,840	25,419
Sample size[b]	**171**	**3,358**	**5,236**	**3,844**	**2,746**	**2,188**	**1,732**	**1,448**	**1,163**	**22,537**	**8,145**	**30,682**

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate. Some observations were dropped, on a variable-by-variable basis, due to missing data.

Outcomes are defined in Table III.3. The low birthweight and very low birthweight outcome measures are binary indicators of birthweight fewer than 2,500 g and fewer than 1,500 g, respectively. The preterm birth outcome measure is a binary indicator of delivery at less than 37 weeks. Small-for-gestational age infants had birthweights below the 10th percentile for gestational age based on race/ethnicity- and gender-specific reference standards. Neonatal infant mortality includes infant deaths occurring fewer than 28 days after birth. Lower than [higher than] recommended weight gain during pregnancy are weight gains 10 percent or more below [above] the IOM recommendations.

[a] The analysis of Medicaid costs excludes Native Americans. Oklahoma Medicaid did not provide cost data for Native Americans because many of these individuals receive care through the IHS, and IHS providers do not necessarily report all services and costs to Oklahoma Medicaid.

[b] Sample size in this row includes all woman-infant dyads, including those for whom one or more outcome variables are missing or not applicable.

g = grams; IHS = Indian Health Service; IOM = Institute of Medicine (now referred to as the National Academies of Science, Engineering and Medicine); WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.MO.6. Characteristics and risk factors associated with WIC participation: Estimates from the propensity score models for the entire sample and Medicaid costs analysis sample

Demographic or socioeconomic characteristic, pregnancy history, or pregnancy risk factor	Entire sample	Medicaid costs analysis sample[a]
Age: 17 years or younger	0.043 (0.012)**	0.029 (0.020)
Age: 18 or 19 years	0.009 (0.008)	0.005 (0.012)
Age: 35 years or older	0.031 (0.010)**	0.022 (0.016)
Race/ethnicity: Hispanic	0.052 (0.011)**	0.041 (0.019)*
Race/ethnicity: Non-Hispanic black	-0.030 (0.007)**	-0.115 (0.013)**
Race/ethnicity: Non-Hispanic American Indian/Alaskan Native	0.040 (0.043)	0.006 (0.059)
Race/ethnicity: Non-Hispanic Asian/Pacific Islander	-0.090 (0.023)**	-0.117 (0.028)**
Race/ethnicity: Non-Hispanic other race	-0.032 (0.037)	-0.064 (0.060)
Race/ethnicity: Non-Hispanic multirace	0.011 (0.013)	0.012 (0.022)
Race/ethnicity: Unknown	-0.056 (0.029)	-0.042 (0.039)
Foreign-born: Yes	0.069 (0.010)**	0.087 (0.019)**
Foreign-born: Unknown	0.009 (0.028)	0.037 (0.052)
Married: Yes	-0.001 (0.005)	-0.005 (0.008)
Married: Unknown	-0.026 (0.030)	-0.007 (0.046)
Education: Less than high school	-0.001 (0.006)	-0.016 (0.009)
Education: Some college, no degree	-0.022 (0.006)**	-0.007 (0.009)
Education: College degree	-0.079 (0.012)**	-0.065 (0.016)**
Rural residence	0.098 (0.006)**	0.089 (0.007)**
Family income >100% FPL	0.045 (0.019)*	0.032 (0.036)
Family income (% FPL)[b]	0.000 (0.000)	-0.000 (0.000)
Prenatal care from public clinic	0.147 (0.005)**	0.168 (0.007)**
SNAP enrollment (mother)	0.051 (0.006)**	0.037 (0.010)**
TANF enrollment (mother)	-0.013 (0.006)**	-0.003 (0.010)**

Demographic or socioeconomic characteristic, pregnancy history, or pregnancy risk factor	Entire sample	Medicaid costs analysis sample[a]
Aged, blind, and/or disabled Medicaid enrollment (mother)	0.044 (0.014)**	0.085 (0.021)**
SNAP enrollment (infant)	0.049 (0.005)**	0.050 (0.009)**
Medicaid managed care beneficiary (mother or infant)	0.030 (0.006)**	--
Infant-only observation in Medicaid files	-0.210 (0.018)**	-0.141 (0.027)**
Mother-only in Medicaid files	-0.170 (0.020)**	-0.121 (0.028)**
Gender is male (infant)	-0.005 (0.004)	-0.006 (0.007)
Pre-pregnancy BMI: Less than 18.5 (underweight)	0.012 (0.010)	-0.014 (0.015)
Pre-pregnancy BMI: 25 to 29.9 (overweight)	0.034 (0.006)**	0.031 (0.009)**
Pre-pregnancy BMI: 30 to 40.4 (obese)	0.077 (0.006)**	0.073 (0.009)**
Pre-pregnancy BMI: 40.5 or more (extremely obese)	0.110 (0.009)**	0.121 (0.019)**
Pre-pregnancy BMI: Unknown	0.020 (0.017)	0.004 (0.021)
Smoked three months before pregnancy: Yes [b]	-0.003 (0.009)	0.014 (0.014)
Smoked three months before pregnancy: Unknown	-0.016 (0.021)	-0.020 (0.031)
Previous Cesarean delivery	0.002 (0.007)	0.021 (0.012)
Previous preterm birth	0.007 (0.012)	-0.002 (0.019)
Previous other poor birth outcomes	0.025 (0.017)	0.036 (0.029)
Pre-pregnancy diabetes	0.057 (0.023)*	0.055 (0.043)
Pre-pregnancy hypertension	0.012 (0.019)	0.026 (0.034)
Inter-pregnancy interval: Short (6–17 months)	0.004 (0.006)	--
Inter-pregnancy interval: Very short (< 6 months)	-0.015 (0.009)	-0.020 (0.013)
Previous live births: 1	-0.047 (0.006)**	-0.038 (0.010)**
Previous live births: 2	-0.094 (0.008)**	-0.082 (0.011)**
Previous live births: 3	-0.134 (0.010)**	-0.124 (0.014)**
Previous live births: 4	-0.127 (0.014)**	-0.108 (0.020)**
Previous live births: 5 or more	-0.162 (0.017)**	-0.159 (0.024)**

Demographic or socioeconomic characteristic, pregnancy history, or pregnancy risk factor	Entire sample	Medicaid costs analysis sample[a]
Previous live births: Unknown	-0.016 (0.048)	-0.006 (0.090)
Previous terminations: 1	0.004 (0.006)	0.001 (0.010)
Previous terminations: 2	0.028 (0.009)**	0.038 (0.017)*
Previous terminations: 3	0.036 (0.015)*	0.049 (0.026)
Previous terminations: 4	0.036 (0.023)	0.049 (0.040)
Previous terminations: 5 or more	0.009 (0.026)	-0.005 (0.045)
Previous terminations: Unknown	-0.067 (0.046)	-0.063 (0.069)
Gestational age: (weeks)	0.004 (0.0023)	-0.001 (0.005)
Gestational age: 37 or 38 weeks	0.007 (0.007)	0.004 (0.011)
Gestational age: 33–36 weeks	-0.030 (0.016)	-0.043 (0.023)
Gestational age: 32 weeks or less	-0.065 (0.042)*	-0.099 (0.060)
Propensity score logit model diagnostics		
Sample size	37,837	13,779
Pseudo R^2	0.07	0.10
Log likelihood	-21,288	-6,996
Likelihood ratio test		
- chi-squared	2,708	1,266
- *p*-value	0.00	0.00

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: This table presents the marginal effects implied by two propensity score models. Specifically, the first and second columns present marginal effects when the propensity score model is estimated with the entire sample and the sample available for measures of Medicaid costs, respectively. Marginal effects are the change in the predicted probability of participating in WIC given a one-unit change in the matching variable, holding all other variables constant. Marginal effects were calculated for each observation that had been included in the propensity score model and then the mean marginal effect was calculated by averaging across all observations. Robust standard errors (in parentheses) were calculated using the delta method. Asterisks indicate statistically significant mean marginal effects at the $p < .01$ (**) and $p < .05$ (*) levels.

[a] The analysis of Medicaid costs includes only fee-for-service recipients. Approximately 64 percent of Medicaid recipients in Missouri are enrolled in Medicaid managed care. Managed care claims in Missouri do not include information about actual costs of services.

[b] Marginal effects are not presented for interaction terms included in the propensity score model. The model included household income categories interacted with household income and number of cigarettes category interacted with number of cigarettes.

BMI = body mass index; FPL = Federal poverty level; SNAP = Supplemental Nutrition Assistance Program; TANF = Temporary Assistance for Needy Families; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Table E.OK.6. Characteristics and risk factors associated with WIC participation: Estimates from the propensity score models for the entire sample and for Medicaid costs analysis sample

Demographic or socioeconomic characteristic, pregnancy history, or pregnancy risk factor	Entire sample	Medicaid costs analysis sample[a]
Age: 17 years or younger	0.054 (0.013)**	0.042 (0.014)**
Age: 18 or 19 years	0.046 (0.008)**	0.036 (0.009)**
Age: 35 years or older	-0.002 (0.011)	0.005 (0.012)
Race/ethnicity: Hispanic	0.051 (0.009)**	0.058 (0.009)**
Race/ethnicity: Non-Hispanic black	-0.020 (0.009)*	-0.019 (0.009)*
Race/ethnicity: Non-Hispanic American Indian/Alaskan Native	-0.068 (0.009)**	-0.010 (0.026)
Race/ethnicity: Non-Hispanic Asian/Pacific Islander	-0.102 (0.022)**	-0.097 (0.022)**
Race/ethnicity: Non-Hispanic other race	0.030 (0.047)	0.035 (0.047)
Race/ethnicity: Non-Hispanic multirace	-0.017 (0.012)	-0.022 (0.016)
Foreign-born: Yes	0.053 (0.010)**	0.045 (0.010)**
Foreign-born: Unknown	-0.081 (0.043)	-0.099 (0.047)*
Married: Yes	-0.006 (0.006)	-0.004 (0.006)
Education: Less than high school	-0.005 (0.006)	0.002 (0.007)
Education: Some college, no degree	-0.042 (0.006)**	-0.044 (0.007)**
Education: College degree	-0.121 (0.014)**	-0.127 (0.015)**
Education: Unknown	-0.063 (0.050)	-0.053 (0.053)
Rural residence	0.091 (0.005)**	0.089 (0.006)**
Family income >100% FPL	-0.009 (0.009)	-0.007 (0.010)
Family income (% FPL)[b]	0.000 (0.000)**	0.000 (0.000)**
Prenatal care from public clinic	0.106 (0.008)**	0.102 (0.008)**
TANF enrollment (mother)	-0.002 (0.007)	-0.004 (0.008)
Aged, blind, and/or disabled Medicaid enrollment (mother)	0.125 (0.029)**	0.113 (0.031)**
Infant-only observation in Medicaid files	-0.148 (0.018)**	-0.154 (0.020)**

Demographic or socioeconomic characteristic, pregnancy history, or pregnancy risk factor	Entire sample	Medicaid costs analysis sample[a]
Gender is male (infant)	0.007 (0.005)	0.006 (0.005)
Pre-pregnancy BMI: Less than 18.5 (underweight)	-0.009 (0.012)	-0.006 (0.013)
Pre-pregnancy BMI: 25 to 29.9 (overweight)	0.024 (0.006)**	0.021 (0.007)**
Pre-pregnancy BMI: 30 to 40.4 (obese)	0.064 (0.006)**	0.062 (0.007)**
Pre-pregnancy BMI: 40.5 or more (extremely obese)	0.082 (0.010)**	0.094 (0.011)**
Pre-pregnancy BMI: Unknown	0.002 (0.023)	-0.001 (0.025)
Smoked three months before pregnancy: Yes [b]	-0.065 (0.040)	-0.048 (0.084)
Smoked three months before pregnancy: Unknown	0.014 (0.008)	0.014 (0.009)
Previous Cesarean delivery	0.019 (0.007)**	0.014 (0.008)
Previous preterm birth	0.026 (0.015)	0.030 (0.017)
Previous other poor birth outcomes	0.012 (0.021)	-0.003 (0.023)
Pre-pregnancy diabetes	0.031 (0.028)	0.021 (0.033)
Pre-pregnancy hypertension	0.036 (0.020)	0.021 (0.023)
Inter-pregnancy interval: Short (6–17 months)	-0.019 (0.007)**	--
Inter-pregnancy interval: Very short (< 6 months)	-0.044 (0.010)**	-0.037 (0.010)**
Previous live births: 1	-0.064 (0.007)**	-0.071 (0.007)**
Previous live births: 2	-0.094 (0.008)**	-0.103 (0.009)**
Previous live births: 3	-0.122 (0.011)**	-0.123 (0.012)**
Previous live births: 4	-0.115 (0.015)**	-0.134 (0.017)**
Previous live births: 5 or more	-0.123 (0.017)**	-0.130 (0.019)**
Previous terminations: 1	0.014 (0.007)*	0.012 (0.008)
Previous terminations: 2	0.033 (0.011)**	0.022 (0.012)
Previous terminations: 3	0.033 (0.020)	0.029 (0.021)
Previous terminations: 4	0.036 (0.027)	0.033 (0.029)
Previous terminations: 5 or more	0.051 (0.028)	0.064 (0.030)*

Demographic or socioeconomic characteristic, pregnancy history, or pregnancy risk factor	Entire sample	Medicaid costs analysis sample[a]
Gestational age: (weeks)	0.004 (0.003)	0.005 (0.003)
Gestational age: 37 or 38 weeks	-0.005 (0.008)	0.002 (0.008)
Gestational age: 33–36 weeks	-0.024 (0.017)	-0.016 (0.018)
Gestational age: 32 weeks or less	-0.083 (0.048)	-0.064 (0.051)
Propensity score logit model diagnostics		
Sample size	30,682	25,419
Pseudo R^2	0.05	0.05
Log likelihood	-16,830	-13,715
Likelihood ratio test		
- chi-squared	1,658	1,388
- *p*-value	0.00	0.00

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: This table presents the marginal effects implied by two propensity score models. The first and second columns present marginal effects when the propensity score model is estimated with the entire sample and the sample available for measures of Medicaid costs, respectively. Marginal effects are the change in the predicted probability of participating in WIC given a one-unit change in the matching variable, holding all other variables constant. Marginal effects were calculated for each observation that had been included in the propensity score model and then the mean marginal effect was calculated by averaging across all observations. Robust standard errors (in parentheses) were calculated using the delta method. Asterisks indicate statistically significant mean marginal effects at the $p < .01$ (**) and $p < .05$ (*) levels.

[a] The analysis of Medicaid costs excludes Native Americans. Oklahoma Medicaid did not provide cost data for Native Americans because many of these individuals receive care through the IHS, and IHS providers do not necessarily report all services and costs to Oklahoma Medicaid.

[b] Marginal effects are not presented for interaction terms included in the propensity score model. The model included household income categories interacted with household income and number of cigarettes category interacted with number of cigarettes.

BMI = body mass index; FPL = Federal poverty level; IHS = Indian Health Service; TANF = Temporary Assistance for Needy Families; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Table E.MO.7. Estimates of the association between any prenatal WIC participation and the primary outcomes

Outcome	WIC participants (1)	Matched comparison group (2)	Difference (SE) (3)	Effect size (4)	Sample size (5)
Birth outcomes					
Low birthweight (%)	7.45	7.70	-0.26 (0.28)	-0.010	37,733
Very low birthweight (%)	1.11	0.95	0.16 (0.07)	0.016	37,733
Small-for-gestational age (%)	11.25	10.87	0.38 (0.43)	0.012	37,729
Neonatal infant mortality (deaths per 1,000)	3.26	2.62	0.64 (0.56)	0.012	37,837
Maternal behaviors					
Breastfeeding at discharge (%)	59.62	57.76	1.86** (0.67)	0.038	34,997
Maternal health					
Pregnancy weight gain lower than recommended (%)	17.71	18.89	-1.18 (0.53)	-0.030	35,494
Pregnancy weight gain higher than recommended (%)	47.31	45.27	2.04** (0.67)	0.041	35,494
Medicaid costs					
Medicaid costs for newborn and mother from birth through 60 days postpartum ($)[a]	6,676	7,256	-580* (226)	-0.056	13,779
Medicaid costs for newborn and mother from the prenatal period through 60 days postpartum ($)[a]	10,073	10,776	-703* (268)	-0.059	13,779

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. Some observations were dropped, on a variable-by-variable basis, due to missing data.

Outcomes are defined in Table III.3. The low birthweight and very low birthweight outcome measures are binary indicators of birthweight fewer than 2,500 g and fewer than 1,500 g, respectively. Small-for-gestational age infants had birthweights below the 10th percentile for gestational age based on race/ethnicity- and gender-specific reference standards. Neonatal infant mortality includes infant deaths occurring fewer than 28 days after birth. Lower than [higher than] recommended weight gain during pregnancy are weight gains 10 percent or more below [above] the IOM recommendations.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in the text, where the propensity score model included gestational age and the full set of covariates shown in Table III.4.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance account for multiple comparisons in the birth outcomes and maternal health domains using methods from Hothorn et al. (2008, 2013).

[a] The analysis of Medicaid costs includes only fee-for-service recipients. Approximately 64 percent of Medicaid recipients in Missouri are enrolled in Medicaid managed care. Managed care claims in Missouri do not include information about actual costs of services.

g = grams; IOM = Institute of Medicine (now referred to as the National Academies of Science, Engineering and Medicine); SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.OK.7. Estimates of the association between any prenatal WIC participation and the primary outcomes

Outcome	WIC participants (1)	Matched comparison group (2)	Difference (SE) (3)	Effect size (4)	Sample size (5)
Birth outcomes					
Low birthweight (%)	7.01	7.61	-0.60 (0.32)	-0.023	30,664
Very low birthweight (%)	1.00	1.11	-0.11 (0.09)	-0.010	30,664
Small-for-gestational age (%)	10.69	11.17	-0.49 (0.47)	-0.016	30,662
Neonatal infant mortality (deaths per 1,000)	3.42	3.03	0.38 (0.69)	0.007	30,682
Maternal behaviors					
Breastfeeding at discharge (%)	67.63	66.04	1.59* (0.66)	0.034	30,129
Maternal health					
Pregnancy weight gain lower than recommended (%)	20.73	23.88	-3.15** (0.62)	-0.076	29,771
Pregnancy weight gain higher than recommended (%)	42.19	39.79	2.40** (0.71)	0.049	29,771
Medicaid costs					
Medicaid costs for newborn and mother from birth through 60 days postpartum ($)[a]	5,692	5,638	54 (115)	0.007	25,419
Medicaid costs for newborn and mother from the prenatal period through 60 days postpartum ($)[a]	9,343	8,919	424** (132)	0.047	25,419

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate. Some observations were dropped, on a variable-by-variable basis, due to missing data.

Outcomes are defined in Table III.3. The low birthweight and very low birthweight outcome measures are binary indicators of birthweight fewer than 2,500 g and fewer than 1,500 g, respectively. Small-for-gestational age infants had birthweights below the 10th percentile for gestational age based on race/ethnicity- and gender-specific reference standards. Neonatal infant mortality includes infant deaths occurring fewer than 28 days after birth. Lower than [higher than] recommended weight gain during pregnancy are weight gains 10 percent or more below [above] the IOM recommendations.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in the text, where the propensity score model included gestational age and the full set of covariates shown in Table III.4.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance account for multiple comparisons in the birth outcomes and maternal health domains using methods from Hothorn et al. (2008, 2013).

[a] The analysis of Medicaid costs excludes Native Americans. Oklahoma Medicaid did not provide cost data for Native Americans because many of these individuals receive care through the IHS, and IHS providers do not necessarily report all services and costs to Oklahoma Medicaid.

g = grams; IHS = Indian Health Service; IOM = Institute of Medicine (now referred to as the National Academies of Science, Engineering and Medicine); SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.MO.8. Estimates of the association between any prenatal WIC participation and the secondary birth outcomes

Outcome	WIC participants (1)	Matched comparison group (2)	Difference (SE) (3)	Effect size (4)	Sample size (5)
Newborn birthweight					
Birthweight (g)	3,240	3,239	1 (6)	0.002	37,733
High birthweight (% > 4000g)	6.50	6.24	0.27 (0.34)	0.011	37,733
Fetal growth					
Large-for-gestational age (%)	7.33	7.01	0.32 (0.36)	0.012	37,729
Full-term low birthweight (% ≥ 37 weeks and < 2,500g)	3.01	3.26	-0.25 (0.23)	-0.014	37,733
Infant mortality					
Overall infant mortality (deaths per 1,000)	6.48	5.00	1.47 (0.90)	0.020	37,837
Postneonatal mortality (deaths per 1,000)	3.22	2.39	0.83 (0.71)	0.016	37,837

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. Some observations were dropped, on a variable-by-variable basis, due to missing data.

Outcomes are defined in Table III.3. Large-for-gestational age infants had birthweights above the 90th percentile for gestational age based on race/ethnicity- and gender-specific reference standards. Overall infant mortality includes infant deaths occurring without one year of birth and postneonatal infant mortality includes infant deaths occurring 28 days through 365 days after birth.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in the text, where the propensity score model included gestational age and the full set of covariates shown in Table III.4.

Robust standard errors are in parentheses. No differences between WIC participants and nonparticipants were statistically significant at the $p < .05$ level.

g = grams; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.OK.8. Estimates of the association between any prenatal WIC participation and the secondary birth outcomes

Outcome	WIC participants (1)	Matched comparison group (2)	Difference (SE) (3)	Effect size (4)	Sample size (5)
Newborn birthweight					
Birthweight (g)	3,246	3,236	10 (6)	0.018	30,664
High birthweight (% > 4000g)	6.21	6.42	-0.21 (0.36)	-0.009	30,664
Fetal growth					
Large-for-gestational age (%)	7.25	7.22	0.03 (0.38)	0.001	30,662
Full-term low birthweight (% ≥ 37 weeks and < 2,500g)	2.40	2.58	-0.18 (0.24)	-0.012	30,664
Infant mortality					
Overall infant mortality (deaths per 1,000)	6.97	7.27	-0.30 (1.13)	-0.004	30,682
Postneonatal mortality (deaths per 1,000)	3.55	4.23	-0.68 (0.90)	-0.011	30,682

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate. Some observations were dropped, on a variable-by-variable basis, due to missing data.

Outcomes are defined in Table III.3. Large-for-gestational age infants had birthweights above the 90th percentile for gestational age based on race/ethnicity- and gender-specific reference standards. Overall infant mortality includes infant deaths occurring without one year of birth and postneonatal infant mortality includes infant deaths occurring 28 days through 365 days after birth.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in the text, where the propensity score model included gestational age and the full set of covariates shown in Table III.4.

Robust standard errors are in parentheses. No differences between WIC participants and nonparticipants were statistically significant at the $p < .05$ level.

g = grams; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.MO.9. Estimates of the association between any prenatal WIC participation and the secondary maternal behavior outcomes

Outcome	WIC participants (1)	Matched comparison group (2)	Difference (SE) (3)	Effect size (4)	Sample size (5)
Smoking during pregnancy					
Smoked during pregnancy (%)	31.19	31.80	-0.62 (0.44)	-0.013	37,390
Smoked during third trimester (%)[a]	27.35	28.36	-1.01 (0.67)	-0.022	22,745
High smoking level during third trimester (%)[a]	5.76	5.79	-0.03 (0.42)	-0.001	22,745
Medium smoking level during third trimester (%)[a]	9.95	10.83	-0.88 (0.61)	-0.029	22,745
Low smoking level during third trimester (%)[a]	11.64	11.74	-0.10 (0.53)	-0.003	22,745
Prenatal care					
Received adequate prenatal care (%, Kessner Index)	79.32	72.42	6.90** (0.60)	0.162	35,818
Received adequate prenatal care (%, APNCU Index)	77.98	69.48	8.50** (0.63)	0.194	34,275
Received adequate prenatal care (%, APNCU-M2 Index)	81.02	72.32	8.70** (0.60)	0.206	34,658
Any Medicaid-paid prenatal care (%, Medicaid claims-based measure)	51.47	53.52	-2.04** (0.41)	-0.041	37,019

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. Some observations were dropped, on a variable-by-variable basis, due to missing data. Outcomes are defined in Table III.3.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in the text, where the propensity score model included gestational age and the full set of covariates shown in Table III.4.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) level, where tests for statistical significance did *not* account for multiple comparisons.

[a] Analyses of smoking in the third trimester are limited to WIC participants who began participation in the first trimester of pregnancy and nonparticipants. The methods are the same as in column (1) in Table III.7.

APNCU = Adequacy of Prenatal Care Utilization; g = grams; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.OK.9. Estimates of the association between any prenatal WIC participation and the secondary maternal behavior outcomes

Outcome	WIC participants (1)	Matched comparison group (2)	Difference (SE) (3)	Effect size (4)	Sample size (5)
Smoking during pregnancy					
Smoked during pregnancy (%)	17.13	16.62	0.51 (0.33)	0.014	28,681
Smoked during third trimester[a] (%)	16.62	16.71	-0.08 (0.49)	-0.002	17,138
High smoking level during third trimester[a] (%)	0.74	0.87	-0.13 (0.14)	-0.015	17,138
Medium smoking level during third trimester[a] (%)	7.22	7.41	-0.18 (0.44)	-0.007	17,138
Low smoking level during third trimester[a] (%)	8.66	8.43	0.23 (0.45)	0.008	17,138
Prenatal care					
Received adequate prenatal care (%, Kessner Index)	73.11	65.58	7.54** (0.69)	0.164	29,212
Received adequate prenatal care (%, APNCU Index)	71.96	62.82	9.14** (0.70)	0.195	28,695
Received adequate prenatal care (%, APNCU-M2 Index)	74.97	65.73	9.24** (0.68)	0.203	28,847
Any Medicaid-paid prenatal care[b] (%, Medicaid claims-based measure)	59.78	55.37	4.41** (0.74)	0.089	24,801

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate. Some observations were dropped, on a variable-by-variable basis, due to missing data. Outcomes are defined in Table III.3.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in the text, where the propensity score model included gestational age and the full set of covariates shown in Table III.4.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) level, where tests for statistical significance did *not* account for multiple comparisons.

[a] Analyses of smoking in the third trimester are limited to WIC participants who began participation in the first trimester of pregnancy and nonparticipants. The methods are the same as in column (1) in Table III.7.

[b] The prenatal care measure in the last row excludes Native Americans. Oklahoma Medicaid did not provide Medicaid claims data for Native Americans because many of these individuals receive care through the IHS, and IHS providers do not necessarily report all services and costs to Oklahoma Medicaid.

APNCU = Adequacy of Prenatal Care Utilization; g = grams; IHS = Indian Health Service; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.MO.10. Smoking during pregnancy among women who reported smoking during the three months before pregnancy, by WIC participation and timing of enrollment in WIC

		Prenatal WIC participants			
			Trimester WIC participation began		
	Nonparticipants	All	First	Second	Third
Quit during first trimester[a] (%)	21.2	19.7*	20.0	19.4*	19.7
Quit during second trimester[b] (%)	9.8	10.1	9.3	10.6	10.9
Quit during third trimester[c] (%)	4.9	4.4	4.3	4.5	4.8
Did not quit during pregnancy[d] (%)	61.2	62.8	63.4*	62.8	61.3
All other smoking patterns[e] (%)	2.9	3.0	3.0	2.8	3.3
Sample size	**3,983**	**10,143**	**4,816**	**3,564**	**1,763**

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate.

This table attempts to disentangle whether differences in smoking during pregnancy in Table E.MO.9 might be causal effects of the WIC program (as opposed to the result of selection bias) by comparing the timing of quitting during pregnancy among WIC participants to the timing among nonparticipants. Nonparticipants were more likely to quit than WIC participants. In addition, WIC participants who entered the program in the first trimester did not quit smoking in their first or second trimester at higher rates than WIC participants who entered the WIC program later in their pregnancies.

This analysis is limited by the fact that smoking during pregnancy is only reported by trimester of pregnancy, not by month. For example, it is not possible to tell whether women who quit smoking during their first trimester did so before or after the first month of WIC participation.

Column percentages might not total 100 percent because of rounding. Asterisks denote statistically significant differences between WIC participants and nonparticipants from Student's t-tests (* $p < 0.05$; ** $p < 0.01$).

[a] Percentage reporting no smoking anytime during pregnancy.

[b] Percentage reporting smoking during first trimester, but not in second and third trimester.

[c] Percentage reporting smoking during first and second trimester, but not during third trimester.

[d] Percentage reporting smoking during first, second and third trimester.

[e] Percentage reporting a smoking pattern that does not fall under any of the categories defined above.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children: WM-II = WIC-Medicaid II Feasibility Study.

Table E.OK.10. Smoking during pregnancy among women who reported smoking during the three months before pregnancy, by WIC participation and timing of enrollment in WIC

		Prenatal WIC participants			
			Trimester WIC participation began		
	Nonparticipants	All	First	Second	Third
Quit during first trimester[a] (%)	14.4	16.8*	18.0**	15.8	15.4
Quit during second trimester[b] (%)	8.3	9.5	9.5	9.7	9.1
Quit during third trimester[c] (%)	3.1	3.7	4.4	3.5	2.3
Did not quit during pregnancy[d] (%)	71.3	67.0**	65.4**	67.3*	70.7
All other smoking patterns[e] (%)	2.9	3.0	2.7	3.7	2.4
Sample size	**1,344**	**3,609**	**1,725**	**1,269**	**615**

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate.

This table attempts to disentangle whether differences in smoking during pregnancy in Table E.OK.9 might be causal effects of the WIC program (as opposed to the result of selection bias) by comparing the timing of quitting during pregnancy among WIC participants to the timing among nonparticipants. The results are somewhat inconclusive. For example, the first row of the table shows WIC participants who began participating in the first trimester were more likely to quit smoking in the first trimester of their pregnancy than nonparticipants (18.0 versus 14.4 percent). However, WIC participants who began participation in the second or third trimesters were *also* more likely to quit smoking in the first trimester, although to a lesser degree (15.8 and 15.4 percent, respectively).

This analysis is limited by the fact that smoking during pregnancy is only reported by trimester of pregnancy, not by month. For example, it is not possible to tell whether women who quit smoking during their first trimester did so before or after the first month of WIC participation.

Column percentages might not total 100 percent because of rounding. Asterisks denote statistically significant differences between WIC participants and nonparticipants from Student's t-tests (* $p < 0.05$; ** $p < 0.01$).

[a] Percentage reporting no smoking anytime during pregnancy.

[b] Percentage reporting smoking during first trimester, but not in second and third trimester.

[c] Percentage reporting smoking during first and second trimester, but not during third trimester.

[d] Percentage reporting smoking during first, second and third trimester.

[e] Percentage reporting a smoking pattern that does not fall under any of the categories defined above.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.MO.11. Timing of WIC enrollment relative to initiation of prenatal care

Month of pregnancy in which WIC participation began	Number of WIC participants	Timing of prenatal care initiation (row percentages)			
		At least one month before WIC participation	In first month of WIC participation	At least one month after WIC participation	Missing on birth certificate
1st month	127	54.3	40.9	1.6	3.1
2nd month	4,084	17.8	76.8	1.5	3.8
3rd month	6,401	12.8	72.1	11.1	4.0
4th month	4,405	7.4	46.8	41.6	4.2
5th month	3,172	4.8	29.6	60.1	5.6
6th month	2,537	2.6	21.4	69.5	6.5
7th month	2,079	1.5	15.5	76.8	6.1
8th month	1,706	1.1	12.9	80.6	5.5
9th month+	2,192	0.0	7.8	85.1	7.1
Any month	**26,703**	**8.3**	**45.2**	**41.6**	**4.9**

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate.

This table attempts to disentangle whether differences in prenatal care in Table E.MO.9 might be causal effects of the WIC program (as opposed to the result of selection bias) by comparing the timing of prenatal care initiation among WIC participants to the timing of WIC participation. For example, if a woman initiates prenatal care before enrolling in WIC, early initiation of care cannot be attributed to WIC participation. Row percentages might not total 100 percent because of rounding.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.OK.11. Timing of WIC enrollment relative to initiation of prenatal care

Month of pregnancy in which WIC participation began	Number of WIC participants	Timing of prenatal care initiation (row percentages)			
		At least one month before WIC participation	In first month of WIC participation	At least one month after WIC participation	Missing on birth certificate
1st month	171	70.8	23.4	1.2	4.7
2nd month	3,358	26.6	68.2	1.7	3.5
3rd month	5,236	18.3	68.8	9.2	3.6
4th month	3,844	12.4	49.2	34.0	4.4
5th month	2,746	7.9	30.9	57.2	4.0
6th month	2,188	5.6	24.4	65.3	4.8
7th month	1,732	4.2	19.1	71.8	5.0
8th month	1,448	1.4	16.4	77.3	4.8
9th month+	1,814	0.2	10.5	83.9	5.5
Any month	**22,537**	**12.8**	**44.2**	**38.7**	**4.2**

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate.

This table attempts to disentangle whether differences in prenatal care in Table E.OK.9 might be causal effects of the WIC program (as opposed to the result of selection bias) by comparing the timing of prenatal care initiation among WIC participants to the timing of WIC participation. For example, if a woman initiates prenatal care before enrolling in WIC, early initiation of care cannot be attributed to WIC participation. Row percentages might not total 100 percent because of rounding.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.MO.12. Estimates of the association between any prenatal WIC participation and the secondary maternal health outcomes

Outcome	WIC participants (1)	Matched comparison group (2)	Difference (SE) (3)	Effect size (4)	Sample size (5)
Developed gestational diabetes (%)	4.97	4.44	0.53 (0.29)	0.025	37,837
Developed gestational hypertension (%)	4.40	4.63	-0.24 (0.30)	-0.011	37,837
Indication of Cesarean section (%, Medicaid claims-based measure)	29.19	28.92	0.27 (0.58)	0.006	35,964

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. Some observations were dropped, on a variable-by-variable basis, due to missing data. Outcomes are defined in Table III.3.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in the text, where the propensity score model included gestational age and the full set of covariates shown in Table III.4.

Robust standard errors are in parentheses. No differences between WIC participants and nonparticipants were statistically significant at the $p < .05$ level.

SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.OK.12. Estimates of the association between any prenatal WIC participation and the secondary maternal health outcomes

Outcome	WIC participants (1)	Matched comparison group (2)	Difference (SE) (3)	Effect size (4)	Sample size (5)
Developed gestational diabetes (%)	3.55	3.15	0.41 (0.26)	0.023	30,682
Developed gestational hypertension (%)	3.80	3.76	0.04 (0.29)	0.002	30,682
Indication of Cesarean section (%, Medicaid claims-based measure)[a]	31.08	30.36	0.72 (0.67)	0.016	24,566

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate. Some observations were dropped, on a variable-by-variable basis, due to missing data. Outcomes are defined in Table III.3.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in the text, where the propensity score model included gestational age and the full set of covariates shown in Table III.4.

Robust standard errors are in parentheses. No differences between WIC participants and nonparticipants were statistically significant at the $p < .05$ level.

[a] The analysis of the prevalence of Cesarean section deliveries excludes Native Americans. Oklahoma Medicaid did not provide Medicaid claims data for Native Americans because many of these individuals receive care through the IHS, and IHS providers do not necessarily report all services and costs to Oklahoma Medicaid.

IHS = Indian Health Service; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.MO.13. Estimates of the association between any prenatal WIC participation and Medicaid costs, by type of cost

Outcome	WIC participants (1)	Matched comparison group (2)	Difference (SE) (3)	Effect size (4)	Sample size (5)
Medicaid costs for the infant					
Medicaid costs for newborn through 60 days after birth ($)	4,033	4,499	-466* (211)	-0.048	13,779
Medicaid costs for the mother					
Medicaid costs for mother for pregnancy, delivery, and through 60 days postpartum ($)	6,040	6,277	-237 (134)	-0.043	13,779
Medicaid costs for mother for pregnancy ($)	3,398	3,520	-123 (102)	-0.030	13,779
Medicaid costs for mother for delivery and postpartum period through 60 days ($)	2,642	2,757	-115 (59)	-0.046	13,779
Inpatient (hospital) Medicaid costs					
Costs paid for infant inpatient claims through 60 days after birth ($)	3,256	3,626	-370* (171)	-0.045	13,779
Costs paid for mother inpatient claims during prenatal period ($)	164	254	-90 (61)	-0.036	13,779
Costs paid for mother inpatient claims for delivery and postpartum period through 60 days ($)	1,965	2,131	-166** (43)	-0.090	13,779
Other (non-inpatient) Medicaid costs					
Costs paid for infant's other (non-inpatient) claims through 60 days after birth ($)	777	873	-95 (50)	-0.049	13,779
Costs paid for mother's other (non-inpatient) claims during prenatal period ($)	3,234	3,267	-33 (70)	-0.012	13,779
Costs paid for mother's other (non-inpatient) claims for delivery and postpartum period through 60 days ($)	677	626	51 (32)	0.038	13,779

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. Outcomes for the first two rows are defined in Table III.3. Inpatient (hospital) costs are defined similarly, but only include costs for Medicaid-paid inpatient claims.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in the text, where the propensity score model included gestational age and the full set of covariates shown in Table III.4.

The analysis of Medicaid costs includes only fee-for-service recipients. Approximately 64 percent of Medicaid recipients in Missouri are enrolled in Medicaid managed care. Managed care claims in Missouri do not include information about actual costs of services.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.OK.13. Estimates of the association between any prenatal WIC participation and Medicaid costs, by type of cost

Outcome	WIC participants (1)	Matched comparison group (2)	Difference (SE) (3)	Effect size (4)	Sample size (5)
Medicaid costs for the infant					
Medicaid costs for newborn through 60 days after birth ($)	2,771	2,800	-29 (108)	-0.004	25,419
Medicaid costs for the mother					
Medicaid costs for mother for pregnancy, delivery, and through 60 days postpartum ($)	6,572	6,119	453** (64)	0.119	25,419
Medicaid costs for mother for pregnancy ($)	3,651	3,282	370** (50)	0.140	25,419
Medicaid costs for mother for delivery and postpartum period through 60 days ($)	2,921	2,838	83** (30)	0.041	25,419
Inpatient (hospital) Medicaid costs					
Costs paid for infant inpatient claims through 60 days after birth ($)	1,741	1,783	-42 (83)	-0.007	25,419
Costs paid for mother inpatient claims during prenatal period ($)	254	277	-23 (27)	-0.022	25,419
Costs paid for mother inpatient claims for delivery and postpartum period through 60 days ($)	2,351	2,356	-6 (23)	-0.004	25,419
Other (non-inpatient) Medicaid costs					
Costs paid for infant's other (non-inpatient) claims through 60 days after birth ($)	1,031	1,017	14 (35)	0.005	25,419
Costs paid for mother's other (non-inpatient) claims during prenatal period ($)	3,397	3,005	393** (32)	0.184	25,419
Costs paid for mother's other (non-inpatient) claims for delivery and postpartum period through 60 days ($)	570	481	89** (14)	0.094	25,419

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate. Outcomes for the first two rows are defined in Table III.3. Inpatient (hospital) costs are defined similarly, but only include costs for Medicaid-paid inpatient claims.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in the text, where the propensity score model included gestational age and the full set of covariates shown in Table III.4.

The analysis of Medicaid costs excludes Native Americans. Oklahoma Medicaid did not provide Medicaid claims data for Native Americans because many of these individuals receive care through the IHS, and IHS providers do not necessarily report all services and costs to Oklahoma Medicaid.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) level, where tests for statistical significance did **not** account for multiple comparisons.

IHS = Indian Health Service; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WM-II = WIC-Medicaid II Feasibility Study.

Table E.MO.14. Estimates of the association between any prenatal WIC participation and measures of health care utilization

Outcome	WIC participants (1)	Matched comparison group (2)	Difference (SE) (3)	Effect size (4)	Sample size (5)
Mothers' utilization of prenatal and labor and delivery health care services					
Number of hospitalizations	1.00	1.02	-0.01* (0.01)	-0.029	37,019
Number of days in a hospital	3.44	3.64	-0.20** (0.04)	-0.061	37,019
Length of hospital stay for delivery (number of days)	3.15	3.26	-0.11** (0.02)	-0.057	37,019
Any ICU admission at delivery (%)	0.52	0.58	-0.06 (0.10)	-0.009	37,019
Number of days in an ICU at delivery	0.04	0.05	-0.01 (0.01)	-0.010	37,019
Number of office visits	4.34	3.85	0.49** (0.07)	0.097	37,019
Number of emergency department visits	0.56	0.54	0.03 (0.02)	0.025	37,019
Mothers' utilization of postpartum health care services up to 60 days postpartum					
Number of hospitalizations (postpartum)	0.02	0.03	-0.00 (0.00)	-0.012	37,019
Number of days in a hospital (postpartum)	0.09	0.09	-0.00 (0.01)	-0.002	37,019
Postpartum care visit (% with visit 21-56 days after delivery)	39.17	33.36	5.81** (0.65)	0.121	37,019
Number of office visits	0.52	0.43	0.09** (0.01)	0.103	37,019
Number of emergency department visits	0.15	0.15	0.00 (0.01)	0.001	37,019
Infants' health care utilization up to 60 days after birth					
Length of hospital stay for birth (number of days)	3.49	3.69	-0.19** (0.07)	-0.031	37,249
Any NICU admission (%, NICU levels 3 or 4)	8.43	9.33	-0.90** (0.35)	-0.032	37,249
Hospitalizations with Level 3 NICU admission: number of days	0.90	1.06	-0.16* (0.07)	-0.028	37,249
Hospitalizations with Level 4 NICU admission: number of days	0.71	0.82	-0.12 (0.06)	-0.021	37,249
Number of hospitalizations (total)	0.91	0.90	0.00 (0.01)	0.008	37,249
Number of days in a hospital (total)	3.85	4.04	-0.19** (0.06)	-0.030	37,249

Outcome	WIC participants (1)	Matched comparison group (2)	Difference (SE) (3)	Effect size (4)	Sample size (5)
Number of office visits (well- or sick-infant)	4.46	4.34	0.13* (0.06)	0.025	37,249
Number of well-infant office visits (EPSDT and other preventive care)	2.36	2.11	0.25** (0.02)	0.164	37,249
Number of EPSDT visits	2.18	1.94	0.23** (0.02)	0.157	37,249
Number of sick-infant (other) office visits	2.11	2.23	-0.12* (0.06)	-0.024	37,249
Number of emergency department visits	0.18	0.18	0.00 (0.01)	0.005	37,249

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. Outcomes are defined in Table E.2. For measures of mother's health care utilization, the sample was limited to mother–infant dyads with Medicaid data for the mother; for measures of infant's health care utilization, the sample was limited to mother–infant dyads with Medicaid data for the infant.

Note that analysis with measures of health care utilization included managed care and fee-for-service beneficiaries in Missouri, but analyses of Medicaid costs only included fee-for-service beneficiaries. See Appendix F, Table F.MO.5 for analyses of health care utilization where the sample was limited to fee-for-service beneficiaries only.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in the text, where the propensity score model included gestational age and the full set of covariates shown in Table III.4.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

[a] Number of unique days in the hospital associated with one or more inpatient claims that included Level 3/Level 4 revenue center charge codes.

SE = standard error; NICU = neonatal intensive care unit; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.OK.14. Estimates of the association between any prenatal WIC participation and measures of health care utilization

Outcome	WIC participants (1)	Matched comparison group (2)	Difference (SE) (3)	Effect size (4)	Sample size (5)
Mothers' utilization of prenatal and labor and delivery health care services					
Number of hospitalizations	1.03	1.03	-0.00 (0.01)	-0.007	24,801
Number of days in a hospital	3.62	3.68	-0.07 (0.07)	-0.021	24,801
Length of hospital stay for delivery (number of days)	3.34	3.32	0.02 (0.03)	0.009	24,801
Any ICU admission at delivery (%)	0.04	0.04	-0.01 (0.03)	-0.003	24,801
Number of days in an ICU at delivery	0.00	0.00	-0.00 (0.00)	-0.004	24,801
Number of office visits	1.78	1.55	0.23** (0.05)	0.087	24,801
Number of emergency department visits	0.84	0.66	0.18** (0.02)	0.115	24,801
Mothers' utilization of postpartum health care services up to 60 days postpartum					
Number of hospitalizations (postpartum)	0.02	0.02	0.00 (0.00)	0.007	24,801
Number of days in a hospital (postpartum)	0.08	0.08	0.01 (0.01)	0.010	24,801
Postpartum care visit (% with visit 21-56 days after delivery)	26.41	23.55	2.86** (0.69)	0.066	24,801
Number of office visits	0.33	0.24	0.09** (0.01)	0.123	24,801
Number of emergency department visits	0.20	0.17	0.03** (0.01)	0.052	24,801
Infants' health care utilization up to 60 days after birth					
Length of hospital stay for birth (number of days)	4.12	4.17	-0.05 (0.10)	-0.007	22,628
Any NICU admission (%, NICU Levels 3 or 4)	2.58	2.70	-0.12 (0.26)	-0.007	22,628
Hospitalizations with Level 3 NICU admission: number of days	0.03	0.01	0.01 (0.01)	0.017	22,628
Hospitalizations with Level 4 NICU admission: number of days	0.04	0.04	0.01 (0.01)	0.008	22,628
Number of hospitalizations (total)	1.02	1.00	0.02** (0.01)	0.068	22,628
Number of days in a hospital (total)	4.28	4.22	0.06 (0.08)	0.010	22,628

Outcome	WIC participants (1)	Matched comparison group (2)	Difference (SE) (3)	Effect size (4)	Sample size (5)
Number of office visits (well- or sick-infant)	6.39	6.09	0.30** (0.08)	0.047	22,628
Number of well-infant office visits (EPSDT and other preventive care)	1.55	1.44	0.11** (0.02)	0.114	22,628
Number of EPSDT visits	1.45	1.36	0.10** (0.01)	0.111	22,628
Number of sick-infant (other) office visits	4.84	4.65	0.19* (0.08)	0.030	22,628
Number of emergency department visits	0.22	0.18	0.04** (0.01)	0.086	22,628

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate. Outcomes are defined in Table E.2. For measures of mother's health care utilization, the sample was limited to mother–infant dyads with Medicaid data for the mother; for measures of infant's health care utilization, the sample was limited to mother–infant dyads with Medicaid data for the infant

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in the text, where the propensity score model included gestational age and the full set of covariates shown in Table III.4.

The analysis of these outcomes excludes Native Americans. Oklahoma Medicaid did not provide Medicaid claims data for Native Americans because many of these individuals receive care through the IHS, and IHS providers do not necessarily report all services and costs to Oklahoma Medicaid.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

[a] Number of unique days in the hospital associated with one or more inpatient claims that included Level 3/Level 4 revenue center charge codes.

IHS = Indian Health Service; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.MO.15. Estimates of the association between prenatal WIC participation and the primary outcomes, by length of WIC participation

Outcome	High WIC participation (1)	Medium WIC participation (2)	Low WIC participation (3)
Birth outcomes			
Low birthweight (%)	-0.16 (0.37)	-0.16 (0.34)	-0.52 (0.32)
Very low birthweight (%)	0.22** (0.08)	0.15 (0.09)	0.11 (0.09)
Small-for-gestational age (%)	-0.05 (0.53)	0.92 (0.49)	0.60 (0.52)
Neonatal mortality (deaths per 1,000)	1.48* (0.71)	0.24 (0.75)	-0.53 (0.80)
Maternal behaviors			
Breastfeeding at discharge (%)	2.17* (0.86)	2.25** (0.76)	0.77 (0.83)
Maternal health			
Had lower than recommended weight gain during pregnancy (%)	-1.25 (0.68)	-0.90 (0.61)	-1.31* (0.65)
Had higher than recommended weight gain during pregnancy (%)	3.09** (0.87)	1.85* (0.77)	0.41 (0.83)
Medicaid costs			
Medicaid costs for newborn and mother from birth through 60 days postpartum ($)[a]	-608* (270)	-569* (270)	-620** (232)
Medicaid costs for newborn and mother from the prenatal period through 60 days postpartum ($)[a]	-678* (314)	-739* (313)	-775** (300)

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. Some observations were dropped, on a variable-by-variable basis, due to missing data. Refer to Table E.4 for sample sizes, by outcome.

Outcomes are defined in Table III.3. The low birthweight and very low birthweight outcome measures are binary indicators of birthweight fewer than 2,500 g and fewer than 1,500 g, respectively. Small-for-gestational age infants had birthweights below the 10th percentile for gestational age based on race/ethnicity- and gender-specific reference standards. Neonatal infant mortality includes infant deaths occurring fewer than 28 days after birth. Lower than [higher than] recommended weight gain during pregnancy are weight gains 10 percent or more below [above] the IOM recommendations.

Each column presents the difference in the outcomes between a group of WIC participants (that is, WIC participants with high, medium, and low participation in columns 1, 2, and 3, respectively) and a corresponding matched comparison group of nonparticipants, where the matched comparison group was constructed with inverse probability weighting, as described in the text. The propensity score model included gestational age and the full set of covariates shown in Table III.4.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

[a] The analysis of Medicaid costs includes only fee-for-service recipients. Approximately 64 percent of Medicaid recipients in Missouri are enrolled in Medicaid managed care. Managed care claims in Missouri do not include information about actual costs of services.

g = grams; IOM = Institute of Medicine (now referred to as the National Academies of Science, Engineering and Medicine); SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.OK.15. Estimates of the association between prenatal WIC participation and the primary outcomes, by length of WIC participation

Outcome	High WIC participation (1)	Medium WIC participation (2)	Low WIC participation (3)
Birth outcomes			
Low birthweight (%)	-0.98* (0.42)	-0.66 (0.37)	0.19 (0.37)
Very low birthweight (%)	-0.11 (0.11)	-0.06 (0.11)	-0.15 (0.10)
Small-for-gestational age (%)	-0.65 (0.59)	-0.70 (0.54)	-0.03 (0.59)
Neonatal mortality (deaths per 1,000)	-0.18 (0.81)	1.89 (0.97)	-1.10 (0.84)
Maternal behaviors			
Breastfeeding at discharge (%)	2.01* (0.82)	1.91* (0.76)	0.24 (0.87)
Maternal health			
Had lower than recommended weight gain during pregnancy (%)	-4.28** (0.77)	-2.79** (0.72)	-1.69* (0.78)
Had higher than recommended weight gain during pregnancy (%)	3.47** (0.90)	2.03* (0.82)	0.66 (0.90)
Medicaid costs			
Medicaid costs for newborn and mother from birth through 60 days postpartum ($)[a]	101 (154)	-46 (131)	102 (131)
Medicaid costs for newborn and mother from the prenatal period through 60 days postpartum ($)[a]	652** (175)	273 (149)	215 (145)

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate. Some observations were dropped, on a variable-by-variable basis, due to missing data. Refer to Table E.4 for sample sizes, by outcome.

Outcomes are defined in Table III.3. The low birthweight and very low birthweight outcome measures are binary indicators of birthweight fewer than 2,500 g and fewer than 1,500 g, respectively. Small-for-gestational age infants had birthweights below the 10th percentile for gestational age based on race/ethnicity- and gender-specific reference standards. Neonatal infant mortality includes infant deaths occurring fewer than 28 days after birth. Lower than [higher than] recommended weight gain during pregnancy are weight gains 10 percent or more below [above] the IOM recommendations.

Each column presents the difference in the outcomes between a group of WIC participants (that is, WIC participants with high, medium, and low participation in columns 1, 2, and 3, respectively) and a corresponding matched comparison group of nonparticipants, where the matched comparison group was constructed with inverse probability weighting, as described in the text. The propensity score model included gestational age and the full set of covariates shown in Table III.4.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

[a] The analysis of Medicaid costs excludes Native Americans. Oklahoma Medicaid did not provide cost data for Native Americans because many of these individuals receive care through the IHS, and IHS providers do not necessarily report all services and costs to Oklahoma Medicaid.

g = grams; IHS = Indian Health Service; IOM = Institute of Medicine (now referred to as the National Academies of Science, Engineering and Medicine); SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.MO.16. Estimates of the association between any prenatal WIC participation and the primary outcomes, by mother's age at the time of birth

Outcome	Age of mother at infant's birth	
	Less than or equal to 17 years (1)	Greater than 17 years (2)
Birth outcomes		
Low birthweight (%)	0.74 (1.23)	-0.17 (0.26)
Very low birthweight (%)	0.20 (0.42)	0.10 (0.07)
Small-for-gestational age (%)	0.56 (1.86)	0.65 (0.38)
Neonatal mortality (deaths per 1,000)	0.60 (4.54)	0.33 (0.55)
Maternal behaviors		
Breastfeeding at discharge (%)	6.44* (3.05)	1.16 (0.62)
Maternal health		
Had lower than recommended weight gain during pregnancy (%)	-4.56 (2.56)	-1.18* (0.50)
Had higher than recommended weight gain during pregnancy (%)	8.07** (2.89)	2.13** (0.62)
Medicaid costs		
Medicaid costs for newborn and mother from birth through 60 days postpartum ($)[a]	1,054 (686)	-143 (181)
Medicaid costs for newborn and mother from the prenatal period through 60 days postpartum ($)[a]	1,042 (842)	293 (209)
Sample size	**1,885**	**35,945**

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. The last row indicates the potential number of mother–infant dyads included in the analysis although, for some outcomes, observations were dropped on a variable-by-variable basis due to missing data. Refer to Table E.4 for sample sizes, by outcome.

Outcomes are defined in Table III.3. The low birthweight and very low birthweight outcome measures are binary indicators of birthweight fewer than 2,500 g and fewer than 1,500 g, respectively. Small-for-gestational age infants had birthweights below the 10th percentile for gestational age based on race/ethnicity- and gender-specific reference standards. Neonatal infant mortality includes infant deaths occurring fewer than 28 days after birth. Lower than [higher than] recommended weight gain during pregnancy are weight gains 10 percent or more below [above] the 6 recommendations.

Each column presents the difference in the outcomes between a group of WIC participants and a corresponding matched comparison group of nonparticipants, where the matched comparison group was constructed with inverse probability weighting, as described in the text. The propensity score model included gestational age and the full set of covariates shown in Table III.4 (with a few minor exceptions when small samples for certain subgroups did not permit the inclusion of rare characteristics). Models were estimated separately for each subgroup.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

[a] The analysis of Medicaid costs includes only fee-for-service recipients. Approximately 64 percent of Medicaid recipients in Missouri are enrolled in Medicaid managed care. Managed care claims in Missouri do not include information about actual costs of services.

IOM = Institute of Medicine (now referred to as the National Academies of Science, Engineering and Medicine); SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.OK.16. Estimates of the association between any prenatal WIC participation and the primary outcomes, by mother's age at the time of birth

Outcome	Age of mother at infant's birth	
	Less than or equal to 17 years (1)	Greater than 17 years (2)
Birth outcomes		
Low birthweight (%)	-1.25 (1.22)	-0.20 (0.29)
Very low birthweight (%)	0.37 (0.45)	-0.09 (0.08)
Small-for-gestational age (%)	-1.30 (2.17)	-0.04 (0.44)
Neonatal mortality (deaths per 1,000)	-1.25 (1.22)	-0.20 (0.29)
Maternal behaviors		
Breastfeeding at discharge (%)	6.13 (3.22)	3.21** (0.66)
Maternal health		
Had lower than recommended weight gain during pregnancy (%)	-1.75 (2.73)	-2.96** (0.60)
Had higher than recommended weight gain during pregnancy (%)	1.70 (3.27)	2.67** (0.69)
Medicaid costs		
Medicaid costs for newborn and mother from birth through 60 days postpartum ($)[a]	655 (409)	86 (106)
Medicaid costs for newborn and mother from the prenatal period through 60 days postpartum ($)[a]	1,574** (447)	451** (120)
Sample size	**1,703**	**28,979**

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate. The last row indicates the potential number of mother–infant dyads included in the analysis although, for some outcomes, observations were dropped on a variable-by-variable basis due to missing data. Refer to Table E.4 for sample sizes, by outcome.

Outcomes are defined in Table III.3. The low birthweight and very low birthweight outcome measures are binary indicators of birthweight fewer than 2,500 g and fewer than 1,500 g, respectively. Small-for-gestational age infants had birthweights below the 10th percentile for gestational age based on race/ethnicity- and gender-specific reference standards. Neonatal infant mortality includes infant deaths occurring fewer than 28 days after birth. Lower than [higher than] recommended weight gain during pregnancy are weight gains 10 percent or more below [above] the IOM recommendations.

Each column presents the difference in the outcomes between a group of WIC participants and a corresponding matched comparison group of nonparticipants, where the matched comparison group was constructed with inverse probability weighting, as described in the text. The propensity score model included gestational age and the full set of covariates shown in Table III.4 (with a few minor exceptions when small samples for certain subgroups did not permit the inclusion of rare characteristics). Models were estimated separately for each subgroup.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

[a] The analysis of Medicaid costs excludes Native Americans. Oklahoma Medicaid did not provide cost data for Native Americans because many of these individuals receive care through the IHS, and IHS providers do not necessarily report all services and costs to Oklahoma Medicaid.

IHS = Indian Health Service; IOM = Institute of Medicine (now referred to as the National Academies of Science, Engineering and Medicine); SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.MO.17. Estimates of the association between any prenatal WIC participation and the primary outcomes, by household income

Outcome	Household income				
	Above or below the Federal Poverty Level (FPL)		Quantiles of household income[a]		
	Less than 100% FPL (1)	Greater or equal to 100% FPL (2)	Quantiles 1–2 (lowest) (3)	Quantile 3 (4)	Quantile 4 (highest) (5)
Birth outcomes					
Low birthweight (%)	-0.03 (0.27)	-1.37 (0.73)	-0.15 (0.31)	0.24 (0.94)	-0.29 (0.50)
Very low birthweight (%)	0.09 (0.07)	0.24 (0.17)	0.10 (0.08)	0.13 (0.22)	0.17 (0.13)
Small-for-gestational age (%)	0.58 (0.41)	0.89 (1.01)	0.49 (0.48)	2.29 (1.27)	0.66 (0.74)
Neonatal mortality (deaths per 1,000)	0.25 (0.58)	0.57 (1.82)	0.62 (0.61)	-2.27 (1.93)	0.16 (1.39)
Maternal behaviors					
Breastfeeding at discharge (%)	1.86** (0.66)	-1.10 (1.69)	0.65 (0.76)	7.61** (2.12)	1.28 (1.23)
Maternal health					
Had lower than recommended weight gain during pregnancy (%)	-1.29* (0.53)	-0.18 (1.37)	-1.46* (0.59)	-1.58 (1.77)	-0.43 (1.04)
Had higher than recommended weight gain during pregnancy (%)	2.48** (0.66)	1.82 (1.73)	2.68** (0.76)	1.99 (2.09)	1.66 (1.26)
Medicaid costs					
Medicaid costs for newborn and mother from birth through 60 days postpartum ($)[b]	-259 (197)	322 (468)	-319 (234)	-742 (787)	360 (314)
Medicaid costs for newborn and mother from the prenatal period through 60 days postpartum ($)[b]	137 (228)	694 (511)	43 (272)	-157 (837)	874* (352)
Sample size	**32,528**	**4,660**	**24,909**	**2,986**	**9,293**
Minimum/maximum income (as percentage of FPL) in subgroup	0/99	100/433	0/0	0.1/42.5	42.6/433

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. The last row indicates the potential number of mother–infant dyads included in the analysis although, for some outcomes, observations were dropped on a variable-by-variable basis due to missing data. Refer to Table E.4 for sample sizes, by outcome.

Outcomes are defined in Table III.3. The low birthweight and very low birthweight outcome measures are binary indicators of birthweight fewer than 2,500 g and fewer than 1,500 g, respectively. Small-for-gestational age infants had birthweights below the 10th percentile for gestational age based on race/ethnicity- and gender-specific reference standards. Neonatal infant mortality includes infant deaths occurring fewer than 28 days after birth. Lower than [higher than] recommended weight gain during pregnancy are weight gains 10 percent or more below [above] the IOM recommendations.

Each column presents the difference in the outcomes between a group of WIC participants and a corresponding matched comparison group of nonparticipants, where the matched comparison group was constructed with inverse probability weighting, as described in the text. The propensity score model included gestational age and the full set of covariates shown in Table III.4 (with a few minor exceptions when small samples for certain subgroups did not permit the inclusion of rare characteristics). Models were estimated separately for each subgroup.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

[a] Due to ties, the first two quantiles are combined, and the other two quantiles are not equally sized.

[b] The analysis of Medicaid costs includes only fee-for-service recipients. Approximately 64 percent of Medicaid recipients in Missouri are enrolled in Medicaid managed care. Managed care claims in Missouri do not include information about actual costs of services.

FPL = Federal poverty level; IOM = Institute of Medicine (now referred to as the National Academies of Science, Engineering and Medicine); SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.OK.17. Estimates of the association between any prenatal WIC participation and the primary outcomes, by household income

Outcome	Household income					
	Above or below the Federal poverty level (FPL)		Quantiles of household income			
	Less than 100% FPL (1)	Greater or equal to 100% FPL (2)	Quantile 1 (lowest) (3)	Quantile 2 (4)	Quantile 3 (5)	Quantile 4 (highest) (6)
Birth outcomes						
Low birthweight (%)	-0.50 (0.33)	0.57 (0.57)	-0.58 (0.51)	0.21 (0.73)	-0.77 (0.62)	0.01 (0.55)
Very low birthweight (%)	-0.07 (0.09)	-0.15 (0.17)	-0.12 (0.14)	-0.12 (0.22)	-0.08 (0.16)	-0.04 (0.15)
Small-for-gestational age (%)	-0.06 (0.49)	-0.38 (0.92)	-0.27 (0.75)	0.65 (1.17)	0.09 (0.91)	-0.52 (0.81)
Neonatal mortality (deaths per 1,000)	0.54 (0.76)	0.02 (1.24)	0.16 (1.17)	1.07 (1.38)	0.48 (1.29)	0.70 (1.33)
Maternal behaviors						
Breastfeeding at discharge (%)	3.20** (0.73)	3.05* (1.42)	2.27* (1.09)	4.68* (1.88)	1.86 (1.28)	1.69 (1.23)
Maternal health						
Had lower than recommended weight gain during pregnancy (%)	-3.30** (0.66)	-1.66 (1.28)	-5.80** (1.02)	-3.71* (1.64)	-1.66 (1.24)	-1.50 (1.12)
Had higher than recommended weight gain during pregnancy (%)	2.58** (0.76)	3.36* (1.54)	5.03** (1.11)	5.17** (1.88)	-0.38 (1.42)	2.70* (1.35)
Medicaid costs						
Medicaid costs for newborn and mother from birth through 60 days postpartum ($)[b]	115 (115)	-53 (260)	191 (168)	-101 (356)	268 (199)	-51 (222)
Medicaid costs for newborn and mother from the prenatal period through 60 days postpartum ($)[b]	497** (131)	382 (280)	672** (191)	314 (375)	790** (233)	336 (240)
Sample size	**24,712**	**5,945**	**11,629[b]**	**3,724[b]**	**7,709**	**7,595**
Minimum/maximum income (as percentage of FPL) in subgroup	0/99	100/1,738	0/0	0.1/30	30.1/85.0	85.0/1,738

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate. The last row indicates the potential number of mother–infant dyads included in the analysis although, for some outcomes, observations were dropped on a variable-by-variable basis due to missing data. Refer to Table E.4 for sample sizes, by outcome.

Outcomes are defined in Table III.3. The low birthweight and very low birthweight outcome measures are binary indicators of birthweight fewer than 2,500 g and fewer than 1,500 g, respectively. Small-for-gestational age infants had birthweights below the 10th percentile for gestational age based on race/ethnicity- and gender-specific reference standards. Neonatal infant mortality includes infant deaths occurring fewer than 28 days after birth. Lower than [higher than] recommended weight gain during pregnancy are weight gains 10 percent or more below [above] the IOM recommendations.

Each column presents the difference in the outcomes between a group of WIC participants and a corresponding matched comparison group of nonparticipants, where the matched comparison group was constructed with inverse probability weighting, as described in the text. The propensity score model included gestational age and the full set of covariates shown in Table III.4 (with a few minor exceptions when small samples for certain subgroups did not permit the inclusion of rare characteristics). Models were estimated separately for each subgroup.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

[a] The analysis of Medicaid costs excludes Native Americans. Oklahoma Medicaid did not provide cost data for Native Americans because many of these individuals receive care through the IHS, and IHS providers do not necessarily report all services and costs to Oklahoma Medicaid.

[b] The quantiles are not equally sized due to ties.

FPL = Federal poverty level; IHS = Indian Health Service; IOM = Institute of Medicine (now referred to as the National Academies of Science, Engineering and Medicine); SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.MO.18. Estimates of the association between any prenatal WIC participation and the primary outcomes in Missouri, by quantile of the propensity score distribution

	Outcome measure						
	Low birth weight (%)	Small for gestational age (%)	Breastfeeding at discharge (%)	Lower than recommended weight gain (%)	Higher than recommended weight gain (%)	Medicaid costs from birth through 60 days postpartum ($)[a]	Medicaid costs from the prenatal period through 60 days postpartum ($)[a]
Quantile 1	-1.523 (0.928)	-0.212 (0.770)	2.330 (1.343)	-2.302 (1.070)*	0.268 (1.337)	-1,550 (538)**	-1,394 (566)*
Quantile 2	-1.973 (0.858)*	-0.223 (0.931)	4.488 (1.552)**	-3.798 (1.195)**	4.019 (1.555)**	247 (535)	628 (562)
Quantile 3	0.008 (0.922)	-0.197 (1.016)	-1.197 (1.704)	-0.780 (1.329)	1.424 (1.723)	-357 (633)	-290 (674)
Quantile 4	-1.814 (0.939)	-0.287 (1.087)	0.675 (1.753)	-1.528 (1.357)	5.044 (1.764)**	-571 (795)	-578 (953)
Quantile 5	-0.425 (0.930)	0.134 (1.153)	-0.625 (1.927)	-2.316 (1.540)	0.404 (1.955)	462 (728)	583 (822)
Quantile 6	0.368 (1.042)	0.388 (1.324)	3.018 (2.111)	-0.389 (1.585)	1.921 (2.106)	-1,156 (786)	-1,951 (1,177)
Quantile 7	-0.361 (1.148)	2.245 (1.328)	0.469 (2.189)	-1.398 (1.820)	3.209 (2.243)	-1,222 (1,072)	-1,368 (1,193)
Quantile 8	-0.643 (1.222)	-1.131 (1.653)	8.437 (2.534)**	0.380 (1.939)	-1.790 (2.491)	-1,527 (1,228)	-1,463 (1,303)
Quantile 9	0.207 (1.172)	0.684 (1.672)	-3.433 (2.619)	-1.439 (2.101)	4.341 (2.662)	58 (544)	-25 (647)
Quantile 10	1.591 (1.139)	1.575 (1.716)	3.678 (2.846)	0.897 (2.211)	2.779 (2.835)	-170 (635)	-290 (837)
Quantiles 1–10 (weighted average)	-0.457 (0.328)	0.298 (0.412)	1.784 (0.667)**	-1.267 (0.524)*	2.162 (0.670)**	-579 (247)*	-615 (288)*
Test: Associations do not vary across the 10 quantiles							
Chi-squared(10)	10.77	4.57	20.23	7.31	10.55	10.65	11.34
p-value	0.291	0.870	0.017	0.605	0.308	0.300	0.253
Sample size	**37,733**	**37,729**	**34,997**	**35,494**	**35,494**	**13,779**	**13,779**

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. The last row indicates the potential number of mother–infant dyads included in the analysis although, for some outcomes, observations were dropped on a variable-by-variable basis due to missing data. Refer to Table E.4 for sample sizes, by outcome. Two birth outcomes, very low birth weight and neonatal mortality, could not be included in these analyses because these outcomes are rare.

Subclassification on the propensity score was used to check for heterogeneity between women who were statistically more or less likely to participate in WIC during their pregnancies in the associations between WIC participation and study outcomes. In this analysis, the sample was partitioned into 10 subclasses based on quantiles of the estimated propensity scores. The propensity score model included gestational age and the full set of covariates shown in Table III.4. Then, mean outcomes for WIC participants and nonparticipants were compared within each subclass. Inverse probability weights were not applied for this analysis since the propensity scores are approximately constant within each subclass (Imbens and Rubin 2015, ch. 17).

Outcomes are defined in Table III.3. Small-for-gestational age infants had birthweights below the 10th percentile for gestational age based on race/ethnicity- and gender-specific reference standards. Neonatal infant mortality includes infant deaths occurring fewer than 28 days after birth. Lower than [higher than] recommended weight gain during pregnancy are weight gains 10 percent or more below [above] the IOM recommendations.

Robust standard errors, in parentheses, were computed in Stata using a custom program to estimate a system of equations by generalized method of moments. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

The final row includes chi-squared test statistics and *p*-values for the hypothesis test that associations between WIC participation and the primary outcome measures were the same across all 10 subclasses.

[a] The analysis of Medicaid costs includes only fee-for-service recipients. Approximately 64 percent of Medicaid recipients in Missouri are enrolled in Medicaid managed care. Managed care claims in Missouri do not include information about actual costs of services.

IOM = Institute of Medicine (now referred to as the National Academies of Science, Engineering and Medicine); WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.OK.18. Estimates of the association between any prenatal WIC participation and the primary outcomes in Oklahoma, by quantile of the propensity score distribution

	Outcome measure						
	Low birth weight (%)	Small for gestational age (%)	Breastfeeding at discharge (%)	Lower than recommended weight gain (%)	Higher than recommended weight gain (%)	Medicaid costs from birth through 60 days postpartum ($)[a]	Medicaid costs from the prenatal period through 60 days postpartum ($)[a]
Quantile 1	-1.605 (1.087)	-1.778 (0.937)	4.703 (1.511)**	-3.760 (1.353)**	2.576 (1.534)	-373 (401)	8 (430)
Quantile 2	0.067 (0.980)	0.775 (1.015)	3.557 (1.677)*	-4.238 (1.496)**	2.404 (1.709)	226 (336)	710 (374)
Quantile 3	0.733 (1.035)	0.355 (1.175)	2.349 (1.773)	-3.389 (1.567)*	2.280 (1.821)	-161 (344)	125 (382)
Quantile 4	0.010 (1.001)	0.024 (1.235)	-0.656 (1.931)	-2.494 (1.737)	3.450 (2.012)	233 (362)	593 (412)
Quantile 5	0.266 (1.056)	2.251 (1.234)	2.011 (2.009)	-1.880 (1.753)	2.062 (2.069)	-15 (397)	501 (427)
Quantile 6	0.471 (1.005)	0.068 (1.349)	2.256 (2.167)	-1.404 (1.840)	3.956 (2.211)	660 (295)*	1,051 (334)**
Quantile 7	0.098 (1.073)	-1.937 (1.530)	-0.643 (2.226)	-1.099 (1.993)	6.233 (2.385)**	-320 (544)	95 (611)
Quantile 8	-2.909 (1.383)*	1.099 (1.588)	2.680 (2.434)	-2.953 (2.259)	1.572 (2.558)	275 (485)	796 (537)
Quantile 9	-3.056 (1.491)*	-0.153 (1.880)	-0.293 (2.716)	-4.270 (2.497)	-2.887 (2.932)	-408 (489)	61 (505)
Quantile 10	-0.891 (1.419)	-4.318 (2.245)	-0.892 (2.834)	-6.266 (2.779)*	2.158 (3.208)	346 (294)	727 (400)
Quantiles 1–10 (weighted average)	-0.682 (0.369)	-0.362 (0.465)	1.508 (0.685)*	-3.175 (0.625)**	2.380 (0.727)**	46 (127)	467 (142)**
Test: Associations do not vary across the 10 quantiles							
Chi-squared(10)	10.77	13.29	9.24	4.83	6.67	8.32	7.14
p-value	0.292	0.150	0.415	0.849	0.671	0.502	0.622
Sample size	**30,664**	**30,662**	**30,129**	**29,771**	**29,771**	**25,419**	**25,419**

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate. The last row indicates the potential number of mother–infant dyads included in the analysis although, for some outcomes, observations were dropped on a variable-by-variable basis due to missing data. Refer to Table E.4 for sample sizes, by outcome. Two birth outcomes, very low birth weight and neonatal mortality, could not be included in these analyses because these outcomes are rare.

Subclassification on the propensity score was used to check for heterogeneity between women who were statistically more or less likely to participate in WIC during their pregnancies in the associations between WIC participation and study outcomes. In this analysis, the sample was partitioned into 10 subclasses based on quantiles of the estimated propensity scores. The propensity score model included gestational age and the full set of covariates shown in Table III.4. Then, mean outcomes for WIC participants and nonparticipants were compared within each subclass. Inverse probability weights were not applied for this analysis since the propensity scores are approximately constant within each subclass (Imbens and Rubin 2015, ch. 17).

Outcomes are defined in Table III.3. Small-for-gestational age infants had birthweights below the 10th percentile for gestational age based on race/ethnicity- and gender-specific reference standards. Neonatal infant mortality includes infant deaths occurring fewer than 28 days after birth. Lower than [higher than] recommended weight gain during pregnancy are weight gains 10 percent or more below [above] the IOM recommendations.

Robust standard errors, in parentheses, were computed in Stata using a custom program to estimate a system of equations by generalized method of moments. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

The final row includes chi-squared test statistics and p-values for the hypothesis test that associations between WIC participation and the primary outcome measures were the same across all 10 subclasses.

[a] The analysis of Medicaid costs excludes Native Americans. Oklahoma Medicaid did not provide cost data for Native Americans because many of these individuals receive care through the IHS, and IHS providers do not necessarily report all services and costs to Oklahoma Medicaid.

IHS = Indian Health Service; IOM = Institute of Medicine (now referred to as the National Academies of Science, Engineering and Medicine); WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table E.19. Summary of Medicaid case management programs for pregnant women and infants in Missouri and Oklahoma

State	Medicaid case management programs
Missouri	• The case management program for high-risk women in the fee-for-service program provides monthly visits to women (in the office or home) to encourage adequate prenatal care and adherence to the recommendations of the prenatal care provider(s). For managed care beneficiaries, the managed care plans administer a case management program offered to all pregnant women enrolled in the plan. An initial assessment is used to identify issues in the women's care plan. Women may be referred to prenatal care providers and the WIC program through the case management program. • There are also case management programs for children. Children are not formally assigned to primary care providers in the fee-for-service program, but they are in the managed care program. • There is no patient-centered medical home program comparable to Oklahoma's program (see below).
Oklahoma	• There is a case management program for high-risk pregnant women, in which certain women can obtain Medicaid coverage for services not typically covered by Medicaid (for example, more ultrasounds or diagnostic tests than are not usually covered) after a specialist has determined the services are medically necessary. These women can have their care coordinated by telephone by a case management nurse. • The State has protocols to contact new Medicaid enrollees (by letter or telephone) and screen the high-risk women into the program. • The State also has a patient-centered medical home program, in which providers receive a supplemental fee (in addition to fee-for-service payments) for coordinating the care of their Medicaid-covered patients.

Source: Interviews with representatives from Missouri and Oklahoma's Medicaid agencies.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

APPENDIX F

PRENATAL ANALYSIS ROBUSTNESS CHECKS AND SENSITIVITY ANALYSES

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The study team conducted a large number of robustness checks to confirm the accuracy of the main results and to explore secondary questions about the associations between prenatal WIC participation and the various outcomes. Results of these analyses are presented in this appendix.

A. Association between prenatal WIC participation and gestational age

The IPW methods used in the main analyses (Chapter III, Section C) adjust for differences in gestational age between WIC participants and nonparticipants (see Chapter III, Section A.3). Controlling for gestational age in this manner addresses concerns about gestational-age bias. However, this approach could attenuate estimates of the association between WIC and the various outcome measures if WIC participation affects gestational age. To address this issue, a discrete time hazard model was estimated to assess the association between WIC participation and gestational age (length of gestation).

The discrete time hazard model estimated the probability of a pregnant woman delivering in week t, conditional on being pregnant at the end of week $t - 1$. The data were reshaped to include one observation for each woman for each week of her pregnancy, up to and including the week she delivered. That is, the sample for each week was restricted to include only the women who had not delivered before the beginning of that week. This sample was then used to estimate the probability of delivering in week t conditional on WIC participation. In each week, a woman was classified as a WIC participant if she had redeemed at least one WIC food instrument before the end of the week, and was otherwise classified as a nonparticipant. The group of nonparticipants includes women who never participated in WIC as well as women who began participating later in their pregnancies.

For each week, IPW was used to create a comparison group of nonparticipants that closely matched the WIC participants on observable characteristics, and this weighted sample was used to measure the proportion of WIC participants and the proportion of matched nonparticipants who delivered in the week. Each propensity score model included the full set of matching variables listed in Chapter III, Table III.4. The association between WIC participation and the probability of delivering in week t was the difference between WIC participants and matched nonparticipants in the proportion of women who delivered in week t. In addition, the proportion of women in each group who delivered in each week can be accumulated to calculate the (implied) proportion of women who remained pregnant through the end of the week for (hypothetical) women who always are classified as WIC participants or are never classified as WIC participants. Standard errors were obtained using pairs cluster bootstrapping methods (clustered by woman) with 1,000 replications.[9]

Similar to the main analysis, the balance tests revealed some important differences between WIC participants and nonparticipants each week (t) before IPW. However, IPW was successful in creating a similar comparison group in each week—that is, achieving balance between the WIC participants and matched nonparticipants in each unique weekly analysis sample. After IPW, summary statistics indicate that both States achieved good balance in all weeks of

[9] To confirm that 1,000 bootstrap repetitions were sufficient in this application, the models for weeks 31 to 36 in Missouri were reestimated using 10,000 replicates. The estimated standard errors from 1,000 and 10,000 replicates were identical for weeks 31, 32, and 33. The standard errors with 1,000 and 10,000 replicates varied slightly for weeks 34 and 35, but the findings related to statistical significance were the same.

pregnancy. Thus, IPW reduced the likelihood that underlying differences between participants and nonparticipants were responsible for estimated associations between WIC participation and the probability of a delivery each week. However, as with all non-experimental designs, the potential for differences in unobserved characteristics or selection bias cannot be completely ruled out.

The discrete time hazard model revealed some differences between WIC participants and matched nonparticipants in the probability of delivering in a certain week, but only for certain stages of pregnancy (Table F.1).

- **Very preterm deliveries.** There were no major differences between WIC participants and matched nonparticipants in the probabilities of a delivery in weeks 20 through 32. The discrete time hazard models imply that a woman in Missouri who began participating in WIC early in her pregnancy (before week 20) would have a 98.23 percent probability of remaining pregnant through the end of week 32, whereas a woman who did not participate in WIC before week 32 would have a 98.08 percent chance of remaining pregnant that long. The difference of 0.15 percentage points in the probability of a very preterm birth is not statistically significant. Similarly, in Oklahoma, the difference between WIC participants (98.11 percent probability of delivery in weeks 20 through 32) and matched nonparticipants (98.10 percent) is not statistically significant.
- **Late preterm deliveries.** In weeks 32 through 36, matched nonparticipants generally had higher rates of delivery than WIC participants did. The differences in the probability of a delivery between the two groups were statistically significant in weeks 33 and 34 in Missouri and in weeks 34 and 35 in Oklahoma (see the first three columns in Tables F.1). The differences between WIC participants and matched nonparticipants in the probability of a delivery were not statistically significant in the other weeks. In Missouri, women who enrolled in WIC at the beginning of their pregnancy had a 91.31 percent probability of a full-term birth, compared to 90.62 percent for matched nonparticipants. This difference of 0.68 percentage points (rounded) was not statistically significant using a cutoff of $p < 0.05$ (standard error = 0.36, $p = 0.057$, RR = 0.93).[10] The week-by-week estimates imply that a woman in Oklahoma who enrolled in WIC at the beginning of her pregnancy had a 90.13 percent probability of a full-term birth (remaining pregnant through the end of week 36), compared to 89.11 percent if she never participated in WIC. This difference of 1.03 percentage points (rounded) was statistically significant (standard error = 0.45, $p = 0.023$), and implies a risk ratio (RR) of 0.91.
- **Term deliveries.** WIC participants and matched nonparticipants had similar probabilities of delivering late in their pregnancies. There were no statistically significant differences between the two groups in the probability of a delivery in weeks 37 through 40.

Two robustness checks were implemented to test the sensitivity of these results to different specifications. First, the matched nonparticipant group was restricted to women who never participated in WIC (rather than women who never participated in WIC *and* women who had not participated by week *t*). Results of this alternative model showed that, in some weeks, the

[10] The RR is the implied probability of a preterm delivery for the WIC participants divided by the implied probability of a preterm delivery for the matched nonparticipants.

difference in the probability of a delivery between WIC participants and matched nonparticipants was larger than the results shown in Tables F.1. The differences between the main model and alternative model are consistent with the hypothesis that women who began participating in WIC in week $t + 1$ or later had lower probabilities of a delivery in week t than women who never participated in WIC—even though neither group had actually participated in WIC as of week t. This raises the concern that IPW might not have completely controlled for unobserved confounding—selection bias—in weeks $t + 1$ and later.

Second, a robustness check confirmed that results were qualitatively similar when the propensity score model included a dummy variable that equaled 1 if the woman had initiated prenatal care visits as of week t (according to the birth certificate).[11] In this model, differences between WIC participants and matched nonparticipants tended to be a little smaller than the results in Tables F.1, which could indicate that selection bias is playing a role but could also indicate that WIC affects the timing of prenatal care initiation (assuming prenatal care increases gestational lengths).

In summary, the discrete time hazard models indicate that, in Oklahoma, participation in WIC at the beginning of pregnancy was associated with a statistically significant reduction of 1.03 percentage points in the probability of a preterm birth (a 9.3 percent reduction, or an RR of 0.91), compared to risk of a preterm birth for women who did not participate in WIC at all. The pattern was similar in Missouri—a reduction of 0.68 percentage points (a 7.2 percent reduction, or an RR of 0.93)—but the difference between WIC participants and matched nonparticipants was not statistically significant (p=0.057).

RRs of less than 1 suggest a reduced risk among the exposed group (in this case, WIC participants). However, the closer the ratio is to 1, the weaker the association. For a point of comparison, the observed associations between WIC participation and risk of preterm birth are weaker than the associations observed between smoking during pregnancy and the risk of a preterm birth. The Institute of Medicine (IOM; now referred to as the National Academies of Science, Engineering and Medicine or NASEM) report on causes, consequences, and prevention of preterm births found that the literature fairly consistently reports the relative risks of not smoking (that is, quitting) were about 0.7 to 0.8 for women who smoke 10 to 20 cigarettes per day and 0.5 to 0.7 for women who smoke 20 or more (Behrman and Butler 2007, p. 91).[12]

The estimates found in the last columns in Tables F.1 are upper-bound estimates of the full association between any WIC participation and preterm birth. Those estimates simulate the (implied) difference in the risk of a preterm birth between women who begin participating in WIC at the beginning of their pregnancies and women who never participated. However, in reality many women began participation in WIC later in their pregnancies (Appendix E, Table

[11] Following the main WM-II analyses, the analyses in Table F.1 do not include prenatal care as a matching variable because of endogeneity concerns: WIC participation in weeks 1 through $t-1$ could affect a woman's prenatal care status in week t.

[12] The document reports RRs for smoking compared with not smoking (x), so the relative risk of *not smoking* is the reciprocal ($1/x$).

E.5), so associations between *typical* (or average) levels of WIC participation and birth outcomes are smaller.

Note that estimated reductions in the probability of preterm birth obtained from the discrete time hazard models are considerably smaller than those estimated in simpler models with one observation per woman. For example, WM-I found a 2.3 to 6.3 percentage point reduction in the probability of a preterm birth (Devaney et al. 1990, Table IV.4)—compared with the upper bound estimates of 0.68 and 1.03 percentage point reductions found in the hazard model analysis. Moreover, the unadjusted estimates reported in Appendix Table E.5 show differences in the probability of a preterm birth of 3.0 and 2.7 percentage points in Missouri and Oklahoma, respectively. Other research has also found that WIC participation is associated with large reductions in preterm birth rates. However, Joyce et al. (2008) argued that these large associations were implausible and were the result of gestational-age bias. The structure of the discrete time hazard model is designed to overcome the concern about gestational-age bias, though unobserved confounding could still affect results.

In light of these results, some caution is merited in interpreting results of the main analyses reported in Section C of Chapter III. Differences in outcomes between WIC participants and matched nonparticipants might be attenuated if, in fact, WIC participation is associated with longer gestational lengths. For example, mean birthweight for infants of WIC participants would likely have been higher, relative to the matched nonparticipants, if the main analysis had not controlled for differences in gestational age between the two groups. More research would be needed to assess the degree to which the main results might be attenuated, but there is good reason to believe that these results are less biased than those of an alternative approach that did not address gestational-age bias.

B. Estimates by trimester of WIC enrollment

To avoid spurious results caused by gestational-age bias, analyses presented in Chapter III focused on differences between prenatal WIC participants and a matched comparison group of nonparticipants with pregnancies of the same gestational lengths. As mentioned in Section D.1.b, this approach is conservative if WIC has an effect on gestational age (particularly on the occurrence of preterm births). The results from the discrete time hazard models show relatively modest associations between WIC participation and length of gestation (Section III.C.3). Nonetheless, one other type of exploratory analyses was available to assess associations between *first-trimester* WIC participation and the study outcomes using two different econometric specifications.

Exploratory analyses presented in Table F.2, columns 3 and 4, do not include gestational age in the propensity score model used to construct the matched comparison group for first trimester WIC participants. (To ease comparisons, columns 1 and 2 in Table F.2 reproduce the results for first trimester WIC participants from Section III.C.1. which did include gestational age in the propensity score model.) This analysis shows that 9.2 percent of first trimester WIC participants in Missouri had a preterm birth, but 10.2 percent of the nonparticipants in this alternative matched comparison group had a preterm birth. Similarly, 10.5 percent of first trimester WIC participants in Oklahoma had a preterm birth, compared with 12.2 percent of the nonparticipants. These differences (1.0 and 1.7 percentage points in Missouri and Oklahoma, respectively) are both statistically significant. Because of the strong correlation between preterm birth and

birthweight, there are also differences between first trimester participants and nonparticipants on measures of low and very low birthweight (statistically significant in Oklahoma only). However, caution should be exercised, because the estimates in column 4 are likely affected by gestational-age bias (see Chapter III, Section A.3). Analyses for second and third trimester WIC participants could be even more influenced by gestational-age bias, and are therefore not presented in this appendix.

Even the results from this analysis in Table F.2, columns 3 and 4, could suffer from gestational-age bias because the comparison group includes women who would have enrolled in WIC later (that is, in their second or third trimesters) but did not have the opportunity to enroll because of a preterm birth. Because the comparison group is not composed of *only* women who would have never enrolled in WIC, the comparison group might have (on average) worse birth outcomes, biasing the results. For this reason, analysis was conducted with an alternative specification that might not suffer from this problem to the same degree. Specifically, women who participated in WIC during their first trimester were compared with a matched comparison group constructed from the pooled sample of (1) women who began WIC participating in WIC during their second trimesters, (2) women who began participating in WIC during their third trimesters, and (3) women who never enrolled in WIC (nonparticipants). Although this specification is more attractive from an econometric perspective, it answers a subtly different policy question than the first specification. Instead of answering "What is the difference in outcomes between first trimester WIC participants and nonparticipants?" this specification answers the question, "What is the difference in outcomes between first trimester WIC participants and women who did not participate in the first trimester?" For Missouri, results with this specification differ from the findings in the primary specification. Columns 5 and 6 of Table F.2 indicate that first trimester WIC participation might be associated with lower rates of preterm birth in Oklahoma, but not with any other birth outcomes. There are two potential explanations. First, WIC might benefit all WIC participants, not only those who participated early in the program. Therefore, the null findings are explained by the fact that the comparison group includes a number of women who did, in fact, participate in WIC. The other explanation is that all the results in Chapter III, Table III.7 and the first four columns of Table F.2 are affected by gestational-age bias and should be disregarded. For Oklahoma, results with this specification confirm the findings from the primary specification: first trimester WIC participation is not associated with better birth outcomes (there is actually a positive association with preterm births), but first trimester WIC participation is associated with higher rates of breastfeeding at discharge, a lower proportion of women with lower-than-recommended weight gain, a higher proportion of women with higher-than-recommended weight gain, and higher Medicaid costs.

C. Alternative matching variables

As discussed in Chapter III, Section A.3, some prior researchers controlled for differences in prenatal care services between WIC participants and nonparticipants. In the WIC-Medicaid II Feasibility Study (WM-II), prenatal care was conceptualized as an outcome variable, and therefore was not included as a control. However, prenatal care can be an appropriate control under two conditions: (1) WIC participation does not affect prenatal care and (2) prenatal care either affects outcomes or prenatal care is correlated with unobservable factors that affect outcomes. There is partial support for the former condition given that descriptive statistics show some but not all WIC participants started prenatal care before participating in WIC (see Appendix E, Table E.11). The second condition is widely accepted: increasing adherence to

recommended prenatal care guidelines is a common policy objective, and other researchers controlled for prenatal care specifically to address selection bias concerns (for example, Devaney et al. 1992, pp. 579–580). Rows 3 and 4 in F.3 replicate the main analyses in Missouri and Oklahoma, respectively, with adequacy of prenatal care included as a matching variable. (To facilitate comparisons across specifications, the first two rows of the table reproduce the main results from Chapter III of this report.) Two separate rounds of matching used two different measures of prenatal care adequacy (in practice the results were very similar between the two rounds). There was little substantive difference between findings from our main analysis and these alternative specifications that matched on prenatal care adequacy.[13] However, in analyses that included adequacy of prenatal care as a matching variable, estimated associations between WIC participation and the outcomes were slightly smaller (than the result in row 1) for five of the nine primary outcomes (and slightly larger for the other four outcomes) in Missouri and slightly smaller for seven of the nine primary outcomes in Oklahoma. Notably, in both States the association between WIC participation and breastfeeding at discharge was smaller after controlling for prenatal care and was no longer statically significant. However, it is unclear how to interpret these results. It is possible that WIC has an effect on breastfeeding initiation because of its effect on prenatal care (and possibly other types of care) and that controlling for this variable is inappropriate. On the other hand, it is possible that controlling for prenatal care reduces selection biases by controlling for a characteristic associated with both WIC participation and breastfeeding initiation.

Another issue, somewhat related to this discussion, is the question of whether it is appropriate to include an indicator for receiving prenatal care from a public clinic as a matching variable; this outcome variable might be considered an outcome, and including it could be inappropriate.[14] Removing this matching variable from the IPW routine does not substantively alter most results (row 5), although two estimates for Medicaid costs became statistically insignificant (in Missouri only).

Finally, row 6 repeats the analysis in Missouri but drops the Supplemental Nutrition Assistance Program (SNAP) participation variable. This makes the analysis similar to the WM-II prenatal analysis conducted in Oklahoma, in which SNAP participation data were not available. The results in row 6 are very similar to those in row 1, which confirms that the availability of this variable in Missouri does not explain differences in the findings between the two States.

D. Alternative WIC participation measures

The second set of robustness checks compares estimates of the association between WIC participation and birth outcomes across three different measures of WIC participation: (1) a measure based on food instrument redemption (the preferred measure, used in all WM-II analyses); (2) a measure based on WIC certification only (the regulatory definition of a WIC participant); and (3) a self-reported measure available from birth certificates. Self-reported measures of participation are available on the new birth certificates, but also in national surveys such as the Pregnancy Risk Assessment Monitoring System; the National Longitudinal Survey of

[13] In addition, section M of this appendix presents results from similar specifications, with a focus on outcome measures included in WIC-Medicaid I.

[14] This variable equals one if a woman had one or more Medicaid claims for received prenatal care and the provider was a public clinic.

Youth; the Panel Study of Income Dynamics; and the Early Childhood Longitudinal Study, Birth Cohort—data that are relatively easy to obtain and include measures of birth outcomes. The use of these data for studying the effect of WIC is quite prevalent, but estimates of the association between WIC participation and birth outcomes based on surveys and birth certificates hinge on the accuracy of self-reported WIC participation (for example, see Kreider et al. 2016).

To the study team's knowledge, there are no directly comparable estimates based on self-reported measures and measures derived from administrative records for the same sample, but the WM-II database can fill this hole in the literature since it contains both administrative data and self-reported data on WIC participation for the same sample. The measure based on WIC certification suffers from a moderate number of false positives (women certified as WIC participants who did not receive food instruments), whereas the self-reported WIC participation measure from the revised birth certificate suffers from a large number of false negatives (see Appendix E, Table E.1). Therefore, analyses with these alternative WIC participation measures (1) include women in the group of WIC participants when they should, in fact, be in the comparison group, or (2) include women in the pool of nonparticipants who actually participated in WIC. Consequently, the results with these two alternative WIC participation measures were expected to be attenuated (closer to zero than in row 1) for most of the estimates with these alternative measures. As seen in the tables, the results were indeed attenuated for almost all of the estimates in Oklahoma, particularly when using the self-reported WIC participation measure (Table F.OK.3, rows 7 and 8). However, that is not always the case in Missouri (Table F.MO.3, rows 7 and 8), raising the question (for future research) of whether there are heterogeneous associations between WIC and the outcomes between women who self-report as WIC participants versus those who do not self-report.

E. Alternative sample inclusion and exclusion criteria

The third set of robustness checks in Tables F.3 reproduces the main results using various alternative sample inclusion and exclusion criteria. With few exceptions, the results with all these specifications were consistent with the main findings.

- Row 9 presents results when the sample is limited to full-term births only, which is a method of addressing concerns of gestational-age bias used in some prior research.
- In row 10, the sample is limited to women who had a Medicaid claim at least 240 days before their delivery date. Different results would be expected with this sample under the hypothesis that a primary function of WIC is to help women enroll in Medicaid earlier and that women who enroll in Medicaid earlier might have higher costs (for example, more prenatal care visits). By restricting the sample to women enrolled in Medicaid for most of their pregnancies, the specification removes this potential pathway for WIC to affect Medicaid costs (and other outcomes). The results are consistent with this hypothesis—the difference in Medicaid costs from the prenatal period through 60 days postpartum between participants and nonparticipants (in column 9) in Missouri falls from −$703 (in row 1 of Table F.MO.3) to –$1,322 (in row 10) and falls in Oklahoma from $424 (in row 1 of Table F.OK.3) to $147 (in row 10, and becomes statistically insignificant). It is also possible, however, that selection biases drive these results because women who enroll in WIC could also be likely to enroll in Medicaid early for reasons other than referrals by the WIC program.

- Next, row 11 in Table F.3 shows that excluding a small number of cases in which only the mother or only the infant was located in the Medicaid files (these observations were included from the primary specifications, as mentioned in Chapter II). Notably, in Oklahoma, Medicaid covered only the mother (not the infant) for 3,377 births (11.0 percent of Medicaid covered births)—2,333 WIC participants and 1,044 non-participants. Excluding the infant-only or mother-only Medicaid covered births does not affect results with Medicaid costs.
- Finally, there is a concern that the fact that infant mortality was slightly higher for WIC participants than the matched comparison group might affect results (column 5 of row 1); for example, if Medicaid costs for these infants are very high, that could skew the estimates in column 8. This is unlikely to be a concern because very few infants die, but row 12 alleviates this concern by reestimating the model without these cases. As expected, the results in row 12 were consistent with the main findings (in row 1). (Rows 13 and 14 of Table F.3 show results for two alternative inclusion and exclusion criteria, discussed further later in this appendix.)

F. Alternative specifications

It is also worth mentioning that the study team compared the results in this study (obtained with inverse probability weighting [IPW] methods) with the results of several alternative model specifications, such as using regression adjustment to control for selection biases instead of IPW. There were few substantive differences in findings from the multivariate regressions and the preferred IPW models regarding the conclusions about the associations between prenatal WIC participation and the primary outcomes (row 15 in Table F.3). There were also few differences in the results when IPW and regression adjustment were used in combination (row 16). Likewise, with few exceptions, results were similar to row 1 under alternative matching methods including subclassification on the propensity score with 10 or 50 blocks (rows 17 and 18, respectively), nearest-neighbor matching (row 19), entropy balancing (row 20), and a minimum-biased estimator (row 21).

Furthermore, Tables F.4 show that results for Medicaid costs were robust to alternative definitions of the outcome variable, such as (1) including the costs for Medicaid claims that started within 60 days of birth but ended after the 60th day (as opposed to prorating these costs), (2) Winsorizing (trimming) the outcome variable for the highest-cost mother–infant dyads, or (3) taking the logarithm of costs. The second and third sets of results confirm that a small number of outliers at the top end of the cost distribution did not drive the results.

The study team also reestimated models that compared primary outcomes between WIC participants and the matched comparison group of nonparticipants using specifications that controlled for an array of hospital dummy variables (hospital-fixed effects) and, separately, an array of county dummy variables (county-fixed effects). The results were similar to the results from main specification, ruling out the hypothesis that differences in outcomes between the two groups could be explained by WIC participants simply being relatively more likely to deliver in hospitals or live in counties that have different outcomes for reasons unrelated to WIC (for example, due to differences in hospital policies).

G. Imputing missing birth certificate outcome data

As noted in Chapter III, data obtained from birth certificates were missing for some mother–infant dyads, on a variable-by-variable basis. In general, this problem was not widespread, and rates of missing data were low and not noticeably different for WIC participants and nonparticipants for the primary outcome variables (Appendix E, Table E.4). As such, in the main analyses, the size of the analysis sample was allowed to vary across outcomes on a variable-by-variable basis. That is, a mother–infant dyad was excluded from the analysis for a particular outcome if the outcome was not observed for that dyad. Missing data could introduce risk of bias, for example if higher-risk mothers were more likely to be WIC participants and more likely to be missing birth certificate data.

Fortunately, many outcome variables and risk factors which are correlated with the missing outcomes are observed in the data which can be used to conduct sensitivity tests. To assess the potential influence of missing data on the results, the study team developed an imputation model to impute (fill in) the missing outcome data. First, they estimated a regression model to determine the empirical relationship between the birth certificate outcomes (such as low birthweight or breastfeeding at discharge) and all the other primary outcomes; selected health care utilization outcomes; gestational age; all matching variables listed in Chapter III, Table III.4; WIC participation; and level of WIC participation (high, medium, or low). Second, after estimating the model, the team used the coefficients from the model impute missing data. For example, there is a strong association between birthweight and gestational age, so if a particular infant was observed to be a preterm birth but birthweight was missing, then a low birthweight was most likely to be imputed. Finally, the associations between WIC and the study outcomes could be analyzed with the completed data.[15]

The results of this analysis are in row 22 of Tables F.3. For both States, the associations between WIC participation and the birth certificate outcomes in row 21 are similar to the results from the main analysis (row 1), alleviating concerns that missing data might bias the main results. The associations between WIC participation and lower-than-recommended maternal weight gain were about 15 percent smaller with the imputed data in Missouri (compared with row 1). Otherwise, the differences between row 22 and row 1 were less than 10 percent (often much less). This analysis indicates that the likely extent of any bias stemming from missing birth certificate data is small.

H. Shifts in the distribution of Medicaid costs

Differences in costs between WIC participants and nonparticipants were calculated across the distribution of Medicaid costs, from the 5th to the 95th percentiles in increments of 5 percent (Figure F.1). For both of the primary measures of Medicaid costs, the associations between WIC

[15] The outcome models continued to use IPW weights, consistent with the main WM-II analysis methods. The imputation model consisted of a system of equations, with one equation for each outcome: low birthweight, very low birthweight (conditional on low birthweight), small for gestational age (SGA), breastfeeding at discharge, and maternal weight gain. Multiple imputation was used to obtain standard errors. In particular, imputed values were generated using the multiple imputation by chained equation method developed by Raghunathan et al. (2001), with 20 replications and a burn-in period of 10. Augmented logit (or multinomial logit) regression models were used to address perfect prediction.

participation and the distribution of Medicaid costs differed between Missouri and Oklahoma, confirming the main finding and providing additional insights.

In Missouri, differences in Medicaid costs occurred across a large fraction of the right end of the distribution—roughly 15 to 20 percent of the sample—but not across the entire distribution (Figure F.MO.1, Panel A). The point estimates show that Medicaid costs from birth through 60 days postpartum were roughly the same for WIC participants and nonparticipants—that is, the estimate is about equal to zero—for most quantiles of the distribution. However, at the top of the distribution, WIC participants had significantly lower Medicaid costs from birth through 60 days postpartum. This indicates that savings in Medicaid costs were concentrated among the Medicaid births with the highest costs. This is not surprising, given that results in Chapter III indicated that much of the Medicaid cost savings accrued from reductions in inpatient costs. The results were qualitatively similar between the left panel (costs from birth through 60 days postpartum) and right panel (costs from the prenatal period through 60 days postpartum), confirming that costs accrued in the prenatal period did not play a major role in the association between WIC participation and Medicaid costs savings in Missouri.

In Oklahoma, the results indicate that Medicaid costs from birth through 60 days postpartum were higher for WIC participants than the matched nonparticipants from the 25th to 85th percentiles, with differences ranging from $61 to $361 (Figure F.OK.1, Panel A). The estimates at the tails of the distribution were imprecisely estimated, but given that the mean difference in costs was $40 across the *entire* distribution, the implication is that prenatal WIC participation was associated with some Medicaid costs savings in one or both tails of the distribution. The results in the right panel indicate that Medicaid costs from birth through 60 days postpartum were higher for WIC participants than the matched nonparticipants from roughly the 10th to the 90th percentiles, with differences between the two groups ranging from $405 to $930. Comparing the left and right panels of Figure F.OK.2 shows that adding prenatal costs to the Medicaid cost measure shifts the point estimates several hundred dollars higher (compared with not including prenatal costs) at most quantiles.[16] As a result, Medicaid costs in Oklahoma were higher for WIC participants—that is, the estimate is greater than zero—for *every* quantile of the distribution, and these differences were statistically significant across most of the distribution.

I. Colocation of WIC and Medicaid services at county health clinics

The analyses in Chapter III revealed some differences between Missouri and Oklahoma in the associations between WIC participation and Medicaid costs for non-inpatient services. Interviews with representatives from Oklahoma's WIC and Medicaid agencies suggest a potential explanation for the association between prenatal WIC participation and outpatient Medicaid costs. The potential explanation stems from the fact that many local WIC clinics in Oklahoma (the places where women sign up for and receive WIC benefits) are at county health clinics. At these local clinics, Oklahoma's WIC and Medicaid services are highly integrated. WIC staff members have the ability to check a woman's Medicaid enrollment using an integrated

[16] For example, at the 50th percentile (that is, the median), Oklahoma WIC participants' Medicaid costs from birth through 60 days were $135 higher (95 percent confidence interval: $62 to $209) than the matched nonparticipants' costs, whereas Medicaid costs from the prenatal period through 60 days postpartum were $514 higher (95 percent confidence interval: $381 to $648) for WIC participants.

computer system and routinely do so as part of the WIC enrollment process. This enables WIC staff to help pregnant women enroll in both WIC and Medicaid during the same visit.

Descriptive statistics showed that about 62 percent of WIC participants in the Oklahoma sample received their WIC benefits through one of these local WIC clinics. Moreover, these women received prenatal care and other services earlier in their pregnancies than women who received WIC services through local clinics that were not colocated with county health departments. For example, WIC participants who received WIC benefits through a colocated local WIC clinic were 11 percentage points more likely than other WIC participants (44 versus 33 percent) to have a Medicaid claim at least eight months before their infant's birth. In addition, among women with a Medicaid-paid prenatal care visit, those who received WIC benefits through a colocated local WIC clinic had their first prenatal care visit more than half a month earlier (on average) than women who received WIC benefits through other local clinics. Finally, one of the robustness checks discussed above and presented in Table F.3 (row 10) shows that this channel is potentially important for explaining higher Medicaid costs among WIC participants. Specifically, when the sample was limited to women who had Medicaid claims early in their pregnancies, the association between WIC participation and Medicaid costs (from the prenatal period through 60 days postpartum) was smaller. These results suggest that integrating WIC and Medicaid programs and data systems could have a beneficial effect in connecting women to prenatal care services, even if the direction of the causal mechanism between the two programs is unknown.

In Missouri the results of analyses exploring the association between WIC participation and outpatient health care services were mixed. WIC participants in Missouri had lower utilization of some types of services (such as Medicaid-paid prenatal care visits) than nonparticipants, but higher utilization of other types of outpatient services (such as postpartum visits). On net, infants' and mothers' outpatient Medicaid costs were similar for WIC participants and nonparticipants. This serves as an interesting point of comparison to Oklahoma, because different State agencies operate the WIC and Medicaid programs in Missouri and they do not have the same degree of integration as Oklahoma. When WIC staff members in Missouri refer women to Medicaid, they are typically telling the women where to sign up for Medicaid, which is usually in another building (according to interviews with representatives from Missouri's WIC and Medicaid agencies). This difference between the States may at least partially explain why outpatient Medicaid costs for mothers in Oklahoma were higher for WIC participants than for the matched comparison group of nonparticipants.

J. Additional analyses of NICU admission rates

In Missouri, the main analyses show that lower Medicaid costs from birth through 60 days postpartum were attributable primarily to lower inpatient costs for WIC infants, relative to infants of matched nonparticipants (Appendix E, Table E.MO.13). (Lower Medicaid costs were also observed for mothers' inpatient costs and infants' non-inpatient costs.) There were several statistically significant differences between infants of WIC participants and matched nonparticipants in Missouri for the utilization of inpatient services in the first 60 days after birth (Appendix E, Table E.MO.14). Relative to the infants of matched nonparticipants, infants of WIC participants in Missouri spent fewer days in the hospital at birth (on average) and were less likely to be admitted to the neonatal intensive care unit (NICU). (Infants of WIC participants also spent fewer days in the NICU and in the hospital fewer days total, but these results were not

statistically significant). In addition, infants of WIC participants had more well-infant office visits than infants of matched nonparticipants. Overall, associations between WIC participation and mothers' and infants' health care utilization in Missouri were largely consistent with the patterns observed in Medicaid costs.

Because of the high cost of NICU admissions, the finding that WIC participation in Missouri was associated with fewer NICU admissions and fewer days in the NICU deserves additional attention. Additional analyses that were conducted to explore why the infants of WIC participants in Missouri might have had lower NICU admission rates and lower inpatient Medicaid costs than matched nonparticipants even though the main findings—both overall and for the fee-for-service population alone—do not indicate that these infants had better birth outcomes.[17] (In fact, the WIC participants had slightly worse birth outcomes, although the differences were not statistically significant.) This analysis was conducted in five steps:

1. A NICU admission dummy variable was interacted with the WIC dummy in the model for Medicaid costs and found that infants of WIC participants infants in Missouri admitted to the NICU were no more expensive than infants who were admitted to the NICU. This indicates that differences in NICU admission rates, not lower severity (cost) for their NICU admissions, have driven the lower infant inpatient Medicaid costs for WIC participants.
2. The groups most responsible for differences in NICU admission rates were identified by interacting the gestational-age categories with the WIC dummy variable. This indicated that infants of WIC participants in Missouri were 1.6 percentage points less likely to be admitted to the NICU than in the matched if fewer than 33 weeks completed gestation, 14.1 percentage points less likely to be admitted to the NICU if they were at 33 to 36 weeks, 2.3 percentage points less likely to be admitted to the NICU at 37 to 38 weeks, and 0.7 percentage points less likely to be admitted to the NICU at full term.
3. NICU admission rates for WIC participants and the matched comparison group of nonparticipants in Missouri were compared, controlling for the primary birth outcome measures (preterm birth, low and very low birthweight, SGA, and neonatal mortality). After over-controlling for these other outcomes in the model, estimates indicate that infants of WIC participants were 2.1 percentage points less likely to be admitted to the hospital, conditional on birth outcomes. This is slightly larger than the estimate of 0.9 percentage points in the main specification (Appendix E, Table E.14), confirming that differences in birth outcomes do not explain the difference in NICU admission rates between WIC participants and nonparticipants; in fact, differences in NICU admission rates between the two groups would have been even larger if the main specification had accounted for the fact that birth outcomes were slightly worse among WIC participants. Similarly, total mother and infant Medicaid costs from delivery through 60 days for the WIC participants were $655 less than the comparison group when the model over-controls for birth outcomes, compared with $580 in the main specification.

[17] As reported in Appendix E, Table E.MO.13, WIC participants in Missouri had lower NICU utilization than the matched comparison group of nonparticipants, and the two groups were matched on gestational age as well as other characteristics. Differences between WIC participants and nonparticipants were larger before IPW than after it (with WIC participants having lower preterm birth rates and NICU utilization than nonparticipants), which is consistent with gestational-age bias.

4. The models that compared NICU admission rates between WIC participants in Missouri and the matched comparison group of nonparticipants were reestimated, controlling for an array of hospital dummy variables (hospital-fixed effects) and, separately, an array of county dummy variables (county-fixed effects). As with the primary outcomes (discussed earlier), the results with NICU admission rates under these alternative specifications were similar to the results from main specification, ruling out the hypothesis that differences in NICU admission rates between the two groups could be explained by WIC participants delivering in hospitals or living in counties that have higher NICU admission rates for reasons unrelated to WIC (for example, due to differences in hospital policies).
5. The diagnosis codes for NICU admissions of infants of WIC participants and nonparticipants in Missouri were tabulated to see if diagnosis codes were much more common among the infants of nonparticipants admitted to the NICU. No diagnoses were particularly more common among the infants of nonparticipants, but that was mostly due to the fact that relatively few infants are admitted to the NICU and infants can be admitted for a wide variety of diagnoses, which makes it difficult to detect patterns in the data.

In all, the results indicate that differences in Medicaid costs between WIC participants and matched nonparticipants are driven in large part by lower NICU admission rates among the WIC participants, rather than the differences in the average cost of NICU admissions. Although the average severity (cost) of NICU admissions was similar for WIC participants and matched nonparticipants, infants of WIC participants in Missouri were less likely than infants of matched nonparticipants to be admitted to the NICU, regardless of gestational age. The lower NICU admission rates among WIC participants cannot be explained by WIC participants delivering more often at hospitals with higher NICU admission rates, or living in counties with higher NICU admission rates. Finally, analysis of the diagnosis codes for NICU admissions of infants of WIC participants and nonparticipants in Missouri identified no particular diagnosis (or set of diagnoses) that could explain why NICU admission rates differed between the two groups.

K. Managed care beneficiaries in Missouri

Another set of robustness checks addressed the limitation of the Missouri data, discussed in Chapter II, that the Medicaid claims data do not include costs for beneficiaries enrolled in Medicaid managed care. First, the characteristics of fee-for-service beneficiaries (for whom Medicaid claims data are available) were compared with the characteristics of managed care beneficiaries. Differences were expected given that managed care and fee-for-service beneficiaries are located in different counties. (For example, the city of St. Louis has managed care.) Compared with the fee-for-service group, managed care beneficiaries are relatively less often Hispanic or white, less often foreign-born or married, more likely to have completed high school, less often from rural areas, less often receive prenatal care at a public clinic, more often have household incomes below the poverty level, and participate in SNAP and TANF at higher rates (Table F.MO.5). Managed care beneficiaries also had higher rates of some pre-pregnancy risk factors. Given these differences in the population across the two groups, one would not necessary expect the associations between WIC participation and the outcomes to be the same.

Second, the analysis with the (primary) outcomes from the primary birth certificate outcome measures was conducted separately with the fee-for-service and managed care beneficiaries. These results, presented in Table F.MO.6, indicate there is some heterogeneity in the associations between WIC participation and maternal behaviors (breastfeeding) and maternal

health (maternal weight gain). There was no association between WIC participation and breastfeeding and maternal weight gain for the fee-for-service beneficiaries, but there were statistically significant associations for the managed care beneficiaries.

Although the Medicaid program is not directly at-risk for the costs of claims paid for health care services for managed care beneficiaries—those claims are paid by the managed care plans—the health care utilization measures can be used to gain insights into the question of whether WIC participation is associated with lower costs for Medicaid beneficiaries enrolled in managed care. For example, if WIC participation is associated with lower hospital utilization among the managed care beneficiaries, readers might infer that this decreased utilization reduces the costs paid by the managed care plans, which might in turn ultimately result in lower payments by the Medicaid program to the managed care plans (depending on how the managed care capitated payments are negotiated). Table F.MO.7 presents the associations between WIC participation and health care utilization for the managed care beneficiaries and the fee-for-service beneficiaries in Missouri. The point estimates indicate the association between WIC and hospital utilization is larger for the fee-for-service beneficiaries than for the managed care beneficiaries, although the estimates are mostly similar. Of note, infants of fee-for-service WIC participants are 2.0 percentage points ($p < .01$) less likely to be admitted to a NICU (compared with fee-for-service nonparticipants), but the managed care beneficiaries are only 0.40 percentage points ($p > .05$) less likely to be admitted to a NICU (compared with managed care nonparticipants). On the other hand, WIC was associated with larger increase in outpatient (nonhospital) utilization. For example, fee-for-service WIC participants in managed care had, on average 013 more office visits ($p < .01$) in the postpartum period compared with managed care nonparticipants, but the fee-for-service WIC participants had only 0.02 more office visits ($p > .05$) compared with fee-for-service nonparticipants.

The results in Table F.MO.7 indicate the associations between WIC participation and measures of Medicaid-covered health care utilization are not the same for fee-for-service and managed care beneficiaries. By extension, associations between WIC participation and Medicaid costs measured with fee-for-service beneficiaries might not translate to the managed care population. To obtain a rough understanding of the association between WIC participation and Medicaid costs (from the delivery through 60 days postpartum) for the managed care beneficiaries, a regression model was estimated to determine the empirical relationship between Medicaid fee-for-service costs and health care utilization outcomes; the other primary outcomes; gestational age; all matching variables listed in Chapter III, Table III.4; dummies for having a cesarean section; any Medicaid-paid prenatal care; having adequate prenatal care; any WIC participation; and level of WIC participation (high, medium, or low).[18] The model was estimated using the fee-for-service beneficiaries, and the model coefficients were used to obtain predicted values—that is, estimated Medicaid costs—for each managed care beneficiary. Then average (imputed) costs were compared between WIC participants and matched nonparticipants in

[18] The key predictor variables in the imputation model are the health care utilization outcomes. The estimated coefficients for these variables can be interpreted as an estimate of the unit prices paid by fee-for-service Medicaid for those health care services. For example, the model includes the number of days hospitalized, and the coefficient can be interpreted as the average cost of one additional day in the hospital among the fee-for-service Medicaid beneficiaries.

managed care.[19] If the managed care beneficiaries had instead been in fee-for-service, the patterns of health care utilization (and other variables included in the model) observed in the data indicate that the managed care WIC participants would have had Medicaid costs from the delivery through 60 days postpartum that were $335 lower than the matched managed care nonparticipants ($5,003 versus $5,338, $p = 0.043$). This is about 30 percent smaller than the comparable estimate for the fee-for-service beneficiaries ($589, from Table F.MO.3, row 12, column 8). Pooling across the managed care and fee-for-service beneficiaries, the average association between WIC participation and Medicaid costs from the delivery through 60 days postpartum is most likely in the neighborhood of $433 ($5,677 versus $6,110, SE=$130, $p = 0.001$).

L. Native American beneficiaries in Oklahoma

The remaining robustness checks address the two limitations of the Oklahoma data, discussed in Chapter II. The first concern arises because the Cherokee and Potawatomi ITO WIC agencies did not provide data on WIC participation. A complex analysis, described in Appendix C, identifies nonparticipants in Oklahoma who were likely to have participated in WIC through a Cherokee or Potawatomi clinic and excluded them from the main analysis. The approach aimed to minimize the risk of bias and maximize the available sample size. Rows 13 and 14 in Table F.OK.3 assess the level of bias that might arise due to misclassification of WIC participants who enrolled through a Cherokee or Potawatomi agency. Both rows present results from models using the full sample of women, including those excluded from the main analyses. In row 13, all women are coded as WIC participants or nonparticipants based on whether the data contained WIC administrative records for them, and thus women excluded from the main analysis are coded as nonparticipants. In row 13, women excluded from the main analysis were included in the analysis and recoded as WIC participants. In row 14, some nonparticipants will be coded as WIC participants, but the number of misclassified women will be smaller than in row 13. Estimates based on both models will be biased toward the null, but one would expect the bias to be smaller under the second model. In practice, this sample has a modest effect on the results. For example, these two rows show Medicaid costs from the prenatal period through 60 days postpartum for WIC participants were $405 and $421 higher than for nonparticipants, well within the confidence interval of the $315 estimate from the main specification (row 1).

The second data limitation in Oklahoma, discussed in Chapter II, was that the Medicaid agency did not provide Medicaid claims data for Native American beneficiaries. Native Americans were excluded from analyses of Medicaid cost and utilization but were included in analyses of outcomes measured on the birth certificate. The results obtained from the Medicaid claims data with non-Native American Medicaid beneficiaries do not appear to be generalizable to the Native American population. First, Table F.OK.8 shows that the two groups differed along some important dimensions—Native American women were younger; had different levels of education; more often lived in rural areas; and had higher rates of pregnancy risk factors (such as lower rates of normal BMI, higher smoking rates, diabetes, and hypertension). Second, Table

[19] The models continued to use IPW weights, consistent with the main analyses presented in Section C in Chapter III. Multiple imputation was used to obtain standard errors that incorporates both within- and between-imputation variability in the estimates (Raghunathan et al. 2001, p. 89). This step used 25 replications because the literature indicated that relatively few imputations are required for valid statistical inference in many applications (for example, see Rubin 1996, p. 480).

F.OK.9 presents results, separately for Native Americans and non-Native Americans, on the associations between WIC participation and the outcomes measured on the birth certificate. Results for the birth outcomes were similar for both groups, but there appears to be heterogeneity in the associations between WIC and weight gain during pregnancy. The associations between WIC participation and pregnancy weight gain were larger for the Native American subgroup than for the non-Native Americans. For example, the Native American WIC participants were 4.4 percentage points more likely to have higher-than-recommended weight gain during pregnancy than their matched comparisons, whereas this difference was only 2.6 percentage points for the non-Native Americans.

M. Replication of WM-I methods

The main findings from WM-II reported in Chapter III are not consistent with findings from WM-I. WM-I found that prenatal WIC participation was associated with savings in Medicaid costs (from birth through 60 days postpartum) in all five study States (Devaney et al. 1990). In contrast, WM-II found savings in one study State but not the other. In addition, WM-I found a favorable association between prenatal WIC participation and birth outcomes, but WM-II did not find such associations.

There are many reasons that associations between WIC participation and the study outcomes might have changed since WM-I was conducted more than 20 years ago. Naturally, readers could be interested in comparing the results from WM-II with the original WM-I study, even if such comparisons are inexact and the studies were conducted in different States. Because of (1) differences in the research methods used and (2) changes in the WIC population over the intervening decades, results from the two studies are not directly comparable.

The purpose of this section is to bridge the gap between WM-I and WM-II by shedding light on how key differences in the research methods used in the two studies affect the main findings. Data from WM-I were not available, so it was not possible to implement the WM-II approach using WM-I data. Instead, supplementary analyses were implemented using the WM-II data to understand how these methodological differences might contribute to differences in findings. Sections M.1 through M.3 describe and summarize these analyses. In addition, Section M.4 presents results of a supplementary analysis that examined the potential contribution of changes in the income levels of WIC participants over time to the differences between WM-I and WM-II findings.

1. Approach

In designing the approach to the analysis, the study team focused on six key differences between the methods used in WM-I and WM-II:

1. **Controlling for gestational age.** The most widely cited, best-known results from WM-I are based on models that did not control for gestational age (Devaney et al. 1990).[20] In WM-II, the IPW model adjusts for differences in gestational age between WIC

[20] The most widely cited WM-I findings were reported in Volume I of the study's final report (Devaney et al. 1990). A second, supplemental analysis, reported in Volume II of the final report, controlled for gestational age. However, results from this analysis have received less attention.

participants and nonparticipants to address concerns about gestational-age bias, which are well documented in the literature since WM-I.

2. **Control variables.** The control variables (or matching variables in the case of WM-II) differed between the two studies, and WM-II included more variables than WM-I. This was partly because the 2003 revised birth certificate includes variables that were unavailable at the time of WM-I and because WM-II included multiple control variables from Medicaid data files.[21]

3. **Use of prenatal care as a control variable.** WM-I used prenatal care adequacy as a control variable. WM-II did not include prenatal care adequacy as a control (matching) variable and instead considered it to be a secondary outcome.[22]

4. **Inclusion of multiple births.** WM-I included multiple births in the study sample, but WM-II included only singleton births.[23]

5. **Adjusting for multiple comparisons.** WM-I did not adjust *p*-values to account for multiple comparisons, whereas WM-II did include this statistical control. Adjusting for multiple comparisons was not a common practice at the time WM-I was conducted.

Seven different model specifications were implemented to isolate the relative influence of these analytic differences between WM-I and WM-II on the different conclusions reached by the two studies:

1. **WM-I methods.** This was the fullest replication of WM-I methods possible using the WM-II data. Regression models were used to estimate the association between prenatal WIC participation and the various outcomes using only the control variables used in WM-I, including adequacy of prenatal care and excluding gestational age, and multiple births were included in the sample.[24,25] Linear regression models (ordinary least squares) were used for Medicaid costs, birthweight, and gestational age, whereas logit models were used for the binary outcome variables.

[21] In WM-I, all control variables were from the birth certificate except one—prenatal care from a public clinic. Variables included in WM-II but not in WM-I are marked with an asterisk in Chapter III, Table III.4.

[22] Chapter III, Section A.3, and earlier Sections A and B of this appendix discuss the rationale for this decision.

[23] Chapter III, Section C discusses the rationale for this decision.

[24] In addition to adequacy of prenatal care, the control variables included male newborn, mother's age, mother's race, married, number of previous live births, number of previous other birth outcomes, mother's education, rural residence, and prenatal care from a public clinic. Because of data limitations, the analysis in WM-I did not include all these control variables for all five States. However, all the variables were available for both Missouri and Oklahoma in WM-II.

[25] The unit of observation is the delivery for analyses of Medicaid costs (that is, the outcome measure includes the Medicaid costs for the mother and all infants associated with the delivery). Otherwise, the unit of observation is the newborn. Following WM-I, a dummy variable for multiple births is includes as a control variable (or matching variable) in all analyses that include multiple births and the male control variable equaled one if at least one newborn was male.

2. **WM-I methods, but control for gestational age.** This specification included gestational age as an additional control variable in the WM-I regression models described earlier.
3. **WM-II methods, but do not control for gestational age.** This specification used WM-II methods but excluded gestational age from the list of matching variables used in the propensity score model.
4. **WM-II methods, but use regression adjustment (not IPW).** This specification is similar to the main WM-II model; however, it used regression models to control for selection bias rather than IPW. Linear regression models (ordinary least squares) were used for Medicaid costs and birthweight, and logit models were used for the binary outcome variables.
5. **WM-II methods, but use matching variables from WM-I other than the adequacy of prenatal care.** This specification uses WM-II methods but limits the matching variables included in in the propensity score model to gestational age and, with the exception of prenatal care adequacy, the control variables used in WM-I.
6. **WM-II methods, but include prenatal care as a matching variable.** This specification uses WM-II methods but adds prenatal care adequacy as an additional matching variable.
7. **WM-II methods, but include multiple births in the sample.** This specification uses WM-II methods but expands the sample to include multiple births.

2. Findings

Table F.10 presents results for the two primary outcomes examined in WM-I—Medicaid costs from birth through 60 days postpartum and mean birthweight—for the main WM-II specification and for the seven alternative specifications. Tables F.11 reports findings for seven other outcomes.

The top row of each table reports results for WM-II. The subsequent numbered rows present results for each of the seven alternative specifications. We eliminate one of the methodological difference between the two studies in Tables F.10 and F.11 by not adjusting the *p*-values used in determining the statistical significance reported for multiple comparisons.

Numbered row 1 in Table F.10 presents results for the fullest replication of WM-I methods possible using the WM-II data. For both States, the results of the WM-I replication are qualitatively more similar to WM-I results than to the WM-II results (unadjusted for multiple comparisons). Findings for Medicaid costs were similar for both WM-I and WM-II models. However, although not statistically significant, the point estimate for Medicaid costs in Oklahoma was large and negative in the WM-I model (an indication that regression-adjusted Medicaid costs were lower for WIC participants than for nonparticipants). In addition, results from the WM-I model indicate that infants born to WIC participants in both States had, on average, higher birthweights than nonparticipants.

These results indicate that differences in the research methods used in WM-I and WM-II contributed to the differences in the studies' findings. Numbered rows 2 through 7 present results for the other alternative specifications described earlier. These specifications were designed to

shed light on which of the methodological differences (other than multiple comparison adjustment) is most important in explaining differences between WM-I and WM-II findings. Key findings are summarized next.

a. Controlling for gestational age

Row 2 in Table F.10 reports results of reestimating the WM-I specification (results reported in row 1) but adding gestational age as a control variable. Row 3 reports results of reestimating the WM-II model *without i*ncluding gestational age as a matching variable. In comparing the WM-II results to the first three alternative specifications, it is clear that controlling for gestational age is an important feature of the WM-II analysis. The two models that do not control for gestational age (numbered rows 1 and 3) found that WIC participation was associated with large Medicaid cost savings and increased birthweight. However, after controlling for gestational age (main WM-II findings and row 2), the differences between WIC participants and nonparticipants were substantively smaller, and six of the eight differences were no longer statistically significant.

b. Use of IPW methods rather than regression models

Row 4 in Table F.10 reports results when regression models were used in place of IPW to estimate associations. Other than this change, the model specifications were identical to the main WM-II specification. The results show that finding from the regression models were qualitatively similar to the main results (highlighted row). Point estimates were similar, an indication that the use of IPW rather than regression models did not have a major influence on WM-II findings.[26]

c. Incorporating additional control variables

Row 5 in Table F.10 reports results of estimating the WM-II models (using IPW), but with only those control variables included in WM-I models. These models did not include smoking before pregnancy, previous adverse birth outcomes, short inter-pregnancy interval, being foreign-born, or household income as matching variables.[27]

Point estimates for the models that do not include the additional control (matching) variables differed somewhat from the main WM-II results (highlighted row). This is to be expected, because WIC participants and nonparticipants differed on many of these characteristics before matching (Section A). However, the influence of these additional matching variables was modest compared with the influence of controlling for gestational age, and was not consistent across States. A comparison of the main WM-II estimates with all matching variables (top row) to the results with the WM-I control variables only (numbered row 5) shows that including the new control variables changes the statistical significance of the finding for Medicaid costs (and more than doubles the point estimate) in Missouri, but not in Oklahoma. In addition, including the expanded set of control variables changes the statistical significance of the finding for birthweight (and decreases the point estimate) in Oklahoma, but not Missouri, though the 95 percent confidence intervals in both analyses overlap in both States.

[26] Appendix F demonstrates that results are also qualitatively unchanged with other types of econometric models.

[27] The model did include gestational age, but not adequacy of prenatal care.

d. Controlling for adequacy of prenatal care

Row 6 in Table F.10 reports results of estimating the WM-II models (using IPW) and including prenatal care adequacy as an additional matching variable. For both outcomes in both States, the point estimates were similar to the main WM-II findings and statistical significance was unchanged. Thus, omitting prenatal care adequacy as a matching variable did not have a major influence on WM-II findings.

e. Including multiple births

Finally, row 7 in Table F.10 shows results of estimating the WM-II models with an expanded analysis sample that includes multiple births. Results were similar to the main WM-II findings because there were relatively few twins, triplets, and quadruplets in the sample.

3. Summary of findings

Collectively, these results illustrate that the most important difference between WM-I and WM-II methods is controlling for gestational age. The matched comparison group constructed for WM-II ensured that nonparticipating mother–infant dyads had pregnancies with the same gestational lengths observed among WIC participants. This effectively eliminated the potential for estimates to be biased by a spurious correlation between gestational age and WIC participation. The most widely cited, best-known results from WM-I are based on models that did not address gestational-age bias. As mentioned previously (footnote **Error! Bookmark not efined.**), a supplementary analysis presented in Volume II of the WM-I final report did include gestational age as a control variable when analyzing effects of WIC among the subset of women who enrolled in WIC in the first trimester (Devaney et al. 1991). These results, presented in Tables F.12, are largely consistent with the findings reported in row 2 in Table F.10—the specification that replicated WM-I methods with WM-II data but added a control for gestational age. Thus, both WM-I and WM-II found that controlling for gestational age reduced the estimates of the association between prenatal WIC participation and Medicaid costs and mean birthweight.

Moreover, in both studies, the effect of controlling for gestational age differed by State. In WM-I, Medicaid cost models that controlled for gestational age still resulted in significant (albeit smaller) coefficient estimates for four of the five States, but reversed the sign of the coefficient in Minnesota (Table F.12). In the WM-II replication of WM-I methods that added a control for gestational age (row 2 in Table F.10), the associations between WIC participation and Medicaid cost savings were smaller in Missouri, relative to the more faithful WM-I replication (row 1 in Table F.10), but remained statistically significant. In Oklahoma, on the other hand, findings from the models that adjusted for gestational age no longer indicated that prenatal WIC participation was associated with Medicaid cost savings (and the sign of the estimate was reversed).

In both WM-I and the WM-II replication of WM-I methods, controlling for gestational age also resulted in lower estimates of the associations between WIC participation and birthweight. In WM-I, these associations remained statistically significant in four of the five States (all but Minnesota) (Table F.12). In the WM-II replication of WM-I, differences in mean birthweight were no longer statistically significant after controlling for gestational age (rows 1 and 2 in Table F.10). Other studies, such as Joyce et al. (2008), have also found that associations between WIC

participation and birth outcomes were smaller after addressing concerns about gestational-age bias.[28]

In addition, because of the 2003 revision to birth certificates, WM-II included a number of variables that were not available to WM-I researchers, including a number of important pre-pregnancy risk factors. Smaller associations between prenatal WIC participation and the various outcomes might be expected if WM-II was more successful than WM-I and other previous studies of prenatal WIC participation at reducing selection biases, but only if there is a systematic negative correlation between observable factors and unobservable factors that affect the study outcomes (Bitler and Currie 2005). This appears to be the case: associations between WIC participation and the study outcomes are smaller when the IPW routine includes these newly available pregnancy risk factors (though including them is not nearly as important as addressing gestational-age bias). It appears selection bias was addressed more credibly in WM-II due to the additional matching variables.

Tables F.11 presents results of the alternative specifications for seven other prominent outcome measures from WM-I—prevalence of low birthweight, gestational age (in weeks), prevalence of preterm birth, three measures of infant mortality, and Medicaid costs for the infant only. Conclusions about the influence of methodological differences between WM-I and WM-II are consistent with those described above.

4. Potential influence of increased incomes of WIC participants on WM-II findings

The WIC and Medicaid programs have expanded since WM-I was conducted, and both programs now serve women and infants at higher income levels than at the time of WM-I. This raises the possibility that results from WM-II, which includes a broader population, might differ from those from WM-I—that is, WIC participants in WM-II could have higher incomes than those in WM-I and thus be at lower risk for poor birth outcomes.[29] Findings reported in Chapter III, Section D.3.b. suggest that differences in income levels do not play a major role in the differences between WM-I and WM-II. For example, despite less restrictive income cutoffs, most mothers and infants have relatively low household incomes—just 14 percent of the Missouri sample and 19 percent of the Oklahoma sample have household incomes above the Federal poverty level. In addition, subgroup analyses based on household income did not reveal strong evidence that the associations between WIC participation and study outcomes consistently varied by income level.

Nonetheless, a more direct assessment of the influence of WIC and Medicaid expansions on study findings can be made through subgroup analyses with the sample of mothers and infants with incomes less than a certain amount. Table F.13 presents results when the main WM-II specification is reestimated, limiting the sample to mothers and infants with incomes less than or

[28] See Colman et al. (2012) for a recent review of the literature.

[29] Another related issue is that there are differences between WM-I and WM-II in the racial or ethnic composition of the WIC population (for example, the proportion of pregnant women who are black or Hispanic) and the associations between WIC participation and study outcomes might be heterogeneous across women with different races or ethnicities. Furthermore, analysis of Medicaid costs in Oklahoma excluded Native Americans. However, it was not possible to assess the potential impact of these differences on WM-II findings because WM-I did not report results by race and ethnicity.

equal to 30, 33, 50, 88, or 100 percent of the FPL.[30] As expected, results are similar when the model is estimated with these different income cutoffs.

While the disparity in findings for WM-I and WM-II could be partially explained by changes in the WIC and Medicaid populations in the intervening period, these subgroup analyses do not indicate that there are large differences in the associations between WIC participation and study outcomes between women with different levels of income. It is more likely that discrepancies between WM-I and WM-II findings are related to methodological differences.

[30] Income cutoffs were chosen based on the description of the WM-I States' Medicaid programs by Bilheimer (1990, p. 65 and Table IV.1).

Table F.MO.1. Estimates of the association between any prenatal WIC participation and gestational length in Missouri: Results from a discrete time hazard model

Week	Probability of delivery in week, conditional on being pregnant at the beginning of the week					Implied probability of remaining pregnant through end of week				
	WIC participants	Matched comparison group	Difference	(SE)	Risk ratio	WIC participants	Matched comparison group	Difference	(SE)	Risk ratio
20	0.03	0.03	0.00	(0.02)	1.04	99.97	99.97	-0.00	(0.02)	1.04
21	0.03	0.04	-0.01	(0.02)	0.72	99.94	99.93	0.01	(0.03)	0.84
22	0.06	0.02	0.04	(0.02)	2.43	99.88	99.91	-0.02	(0.03)	1.26
23	0.04	0.04	0.01	(0.02)	1.15	99.84	99.87	-0.03	(0.04)	1.23
24	0.09	0.07	0.02	(0.03)	1.33	99.75	99.80	-0.05	(0.05)	1.26
25	0.12	0.12	0.00	(0.04)	1.02	99.63	99.69	-0.05	(0.06)	1.17
26	0.07	0.09	-0.03	(0.03)	0.72	99.56	99.59	-0.03	(0.07)	1.07
27	0.13	0.16	-0.03	(0.05)	0.81	99.43	99.43	0.00	(0.08)	0.99
28	0.15	0.16	-0.01	(0.05)	0.91	99.29	99.27	0.02	(0.10)	0.98
29	0.18	0.14	0.05	(0.04)	1.33	99.11	99.13	-0.03	(0.11)	1.03
30	0.21	0.20	0.02	(0.05)	1.09	98.89	98.94	-0.04	(0.12)	1.04
31	0.26	0.41	-0.15	(0.07)*	0.63	98.64	98.54	0.10	(0.14)	0.93
32	0.42	0.46	-0.05	(0.09)	0.90	*98.23*	*98.08*	*0.15*	*(0.16)*	*0.92*
33	0.51	0.79	-0.28	(0.10)**	0.65	97.73	97.31	0.42	(0.19)*	0.84
34	1.02	1.37	-0.35	(0.14)*	0.75	96.73	95.98	0.76	(0.24)**	0.81
35	1.71	1.95	-0.24	(0.18)	0.88	95.08	94.10	0.98	(0.29)**	0.83
36	3.97	3.70	0.27	(0.25)	1.07	*91.31*	*90.62*	*0.68*	*(0.36)*	*0.93*
37	9.63	9.19	0.44	(0.41)	1.05	82.51	82.29	0.22	(0.51)	0.99
38	22.79	22.60	0.19	(0.61)	1.01	63.71	63.69	0.01	(0.63)	1.00
39	56.50	55.03	1.47	(0.87)	1.03	27.71	28.64	-0.93	(0.62)	1.01
40	76.80	78.00	-1.19	(1.09)	0.98	6.43	6.30	0.13	(0.34)	1.00
Joint test – H_0: No difference in weeks 20 through 32					chi-squared(13) = 11.64 p = 0.56					
Joint test – H_0: No difference in weeks 20 through 36					chi-squared(17) = 26.58 p = 0.06					

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. The analysis included 735,583 person-week observations for 37,837 mothers. The model did not estimate the probability of a delivery at weeks 41 and later because small sample sizes precluded estimating the propensity score model (there were 2,539 person-week observations in weeks 41 to 44); however, the model for weeks 20 to 40 included women who delivered at weeks 41 and longer.

This table uses discrete time hazard model to explore a possible association between WIC participation and gestational age. The first four columns present the probability of a woman delivering in week t, conditional on a woman still being pregnant at the end of week $t-1$. The last four columns present the probability of not delivering through the end of week t implied by the first four columns. Specifically, if h_{gt} is the hazard rate for group g in week t, then the probability of delivery after the end of the week is $\Pi_{\tau=1}^{t}\left(1-h_{gt}\right)$. The risk ratio is the probability of a delivery for the treatment group divided by the probability of a delivery for the comparison group.

In each week, the matched comparison group of nonparticipants was constructed with IPW, as described in the text, so that the propensity score model included the full set of covariates shown in Chapter III, Table III.4.

Robust standard errors are in parentheses. Standard errors were obtained using pairs cluster bootstrapping methods (clustered by woman) with 1,000 replications. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < 0.01$ (**) or the $p < 0.05$ (*) levels.

IPW = inverse probability weighting; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table F.OK.1. Estimates of the association between any prenatal WIC participation and gestational length in Oklahoma: Results from a discrete time hazard model

	Probability of delivery in week, conditional on being pregnant at the beginning of the week					Implied probability of remaining pregnant through end of week				
Week	WIC participants	Matched comparison group	Difference	(SE)	Risk ratio	WIC participants	Matched comparison group	Difference	(SE)	Risk ratio
20	0.03	0.05	-0.03	(0.03)	0.46	99.97	99.95	0.03	(0.03)	0.46
21	0.05	0.04	0.01	(0.02)	1.20	99.93	99.90	0.02	(0.04)	0.77
22	0.05	0.03	0.02	(0.02)	1.58	99.88	99.88	0.00	(0.04)	0.97
23	0.08	0.05	0.03	(0.03)	1.50	99.80	99.82	-0.02	(0.05)	1.12
24	0.07	0.10	-0.02	(0.04)	0.76	99.73	99.73	0.00	(0.07)	1.00
25	0.12	0.13	0.00	(0.04)	0.98	99.60	99.60	0.00	(0.08)	0.99
26	0.12	0.21	-0.09	(0.06)	0.56	99.49	99.39	0.09	(0.10)	0.85
27	0.13	0.15	-0.03	(0.05)	0.81	99.36	99.24	0.12	(0.11)	0.84
28	0.14	0.11	0.03	(0.04)	1.25	99.23	99.13	0.09	(0.12)	0.89
29	0.13	0.16	-0.03	(0.05)	0.81	99.10	98.98	0.12	(0.13)	0.88
30	0.22	0.21	0.01	(0.06)	1.04	98.88	98.76	0.12	(0.14)	0.91
31	0.33	0.30	0.03	(0.08)	1.11	98.55	98.47	0.08	(0.16)	0.95
32	0.45	0.38	0.08	(0.09)	1.20	*98.11*	*98.10*	*0.01*	*(0.18)*	*1.00*
33	0.60	0.61	-0.01	(0.11)	0.98	97.52	97.50	0.02	(0.21)	0.99
34	1.11	1.48	-0.37	(0.18)*	0.75	96.44	96.06	0.38	(0.27)	0.90
35	1.99	2.45	-0.46	(0.23)*	0.81	94.53	93.71	0.81	(0.34)*	0.87
36	4.65	4.91	-0.27	(0.33)	0.95	*90.13*	*89.11*	*1.03*	*(0.45)**	*0.91*
37	11.25	11.57	-0.32	(0.49)	0.97	79.99	78.79	1.20	(0.59)*	0.94
38	25.14	25.91	-0.76	(0.71)	0.97	59.88	58.38	1.50	(0.72)*	0.96
39	64.08	63.67	0.41	(0.94)	1.01	21.51	21.21	0.30	(0.60)	1.00
40	83.16	82.20	0.96	(1.21)	1.01	3.62	3.77	-0.15	(0.28)	1.00
Joint test – H_0: No difference in weeks 20 through 32					chi-squared(13) = 7.63 p = 0.87					
Joint test – H_0: No difference in weeks 20 through 36					chi-squared(17) = 17.41 p = 0.43					

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 with a Vital Records birth certificate. The analysis included 591,870 person-week observations for 30,682 mothers. The model did not estimate the probability of a delivery at weeks 41 and later, because small sample sizes preclude estimating the propensity score model (there were 1,191 person-week observations in weeks 41 to 44); however, the model for weeks 20 to 40 included women who delivered at weeks 41 and longer.

This table uses discrete time hazard model to explore a possible association between WIC participation and gestational age. The first four columns present the probability of a woman delivering in week t, conditional on a woman still being pregnant at the end of week $t-1$. The last four columns present the probability of not delivering through the end of week t implied by the first four columns. Specifically, if h_{gt} is the hazard rate for group g in week t, then the probability of delivery after the end of the week is $\Pi_{\tau=1}^{t}\left(1-h_{gt}\right)$. The risk ratio is the probability of a delivery for the treatment group divided by the probability of a delivery for the comparison group.

In each week, the matched comparison group of nonparticipants was constructed with IPW, as described in the text, where the propensity score model included the full set of covariates shown in Chapter III, Table III.4.

Robust standard errors are in parentheses. Standard errors were obtained using pairs cluster bootstrapping methods (clustered by woman) with 1,000 replications. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < 0.01$ (**) or the $p < 0.05$ (*) levels.

IPW = inverse probability weighting; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children WM-II = WIC-Medicaid II Feasibility Study.

Table F.2. Estimates of the association between prenatal WIC participation and the primary outcomes in Missouri and Oklahoma, by trimester of WIC enrollment

Outcome	Comparison of first-trimester WIC participants to nonparticipants				Comparison of first-trimester WIC participants to all other women (not matched on gestation)	
	Matched on gestation		Not matched on gestation			
	MO (1)	OK (2)	MO (3)	OK (4)	MO (5)	OK (6)
Birth outcomes						
Preterm birth (%)	n.a.	n.a.	-1.04*	−1.70**	0.48	0.82*
			(0.52)	(0.59)	(0.35)	(0.39)
Low birthweight (%)	-0.07	−1.25**	-0.68	−1.92**	0.37	0.01
	(0.39)	(0.43)	(0.46)	(0.52)	(0.33)	(0.34)
Very low birthweight (%)	0.25*	−0.26	-0.15	−0.57*	0.15	0.11
	(0.10)	(0.13)	(0.19)	(0.22)	(0.14)	(0.14)
Small for gestational age (%)	0.64	−0.74	0.75	−0.76	0.11	−0.21
	(0.54)	(0.58)	(0.54)	(0.58)	(0.39)	(0.40)
Neonatal mortality (deaths per 1,000)	1.07	0.08	0.63	−0.38	0.79	0.02
	(0.78)	(0.96)	(0.87)	(1.07)	(0.74)	(0.82)
Maternal behaviors						
Breastfeeding at discharge (%)	1.84*	1.54	1.72*	1.54	0.72	1.35*
	(0.88)	(0.82)	(0.88)	(0.82)	(0.59)	(0.60)
Maternal health						
Had lower than recommended weight gain during pregnancy (%)	-0.73	−3.85**	-0.83	−3.94**	-0.07	−1.58**
	(0.70)	(0.75)	(0.70)	(0.75)	(0.48)	(0.53)
Had higher than recommended weight gain during pregnancy (%)	2.31**	3.42**	2.42**	3.49**	0.92	1.61*
	(0.89)	(0.87)	(0.88)	(0.87)	(0.60)	(0.63)
Medicaid costs						
Medicaid costs for newborn and mother from birth through 60 days postpartum ($)[a,b]	-635*	18	-861*	-147	-98	307**
	(305)	(171)	(354)	(203)	(236)	(124)
Medicaid costs for newborn and mother from the prenatal period through 60 days postpartum ($)[a,b]	-675	599**	-868*	430	172	824**
	(349)	(195)	(390)	(226)	(258)	(135)

Source: WM-II database for Missouri and Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 and in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate. Some observations were dropped, on a variable-by-variable basis, due to missing data. Refer to Appendix E, Table E.4 for sample sizes, by outcome and group.

Outcomes are defined in Chapter III, Table III.3. The low birthweight and very low birthweight outcome measures are binary indicators of birthweight fewer than 2,500 g and fewer than 1,500 g, respectively. The preterm birth outcome is a binary indicator of delivery before 37 weeks. Small-for-gestational-age infants had birthweights below the 10th percentile for gestational age based on race/ethnicity- and gender-specific reference standards. Neonatal infant mortality includes infant deaths occurring less than 28 days after birth.

Lower than [higher than] recommended weight gain during pregnancy are weight gains 10 percent or more below [above] the Institute of Medicine recommendations.

The first two columns present the results from Table III.7 for comparability. The first four columns present the difference in the outcomes between WIC participants who began participation in the first trimesters and a corresponding matched comparison group of nonparticipants, where the matched comparison group of participants was constructed with inverse probability weighting, as described in the text. In the last two columns, WIC participants who began participation in the first trimester are compared to a matched comparison group that includes women who did not participate in the first trimester (nonparticipants plus women who began participation in their second and third trimesters). In the first two columns, the propensity score model included gestational age and the full set of covariates shown in Chapter III, Table III.4. In the last four columns, the propensity score model included only the set of covariates shown in Chapter III, Table III.4 (without gestational age).

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

[a] The analysis of Medicaid costs in Missouri includes only fee-for-service recipients. Approximately 64 percent of Medicaid recipients in Missouri receive care through Medicaid managed care plans. Medicaid managed care claims in Missouri do not include information about actual costs of services.

[b] The analysis of Medicaid costs excludes Native Americans. Oklahoma Medicaid did not provide cost data for Native Americans because many of these individuals receive care through the IHS, whose providers do not necessarily report all services and costs to Oklahoma Medicaid.

g = grams; IHS = Indian Health Service; MO = Missouri; OK = Oklahoma; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM –II = WIC-Medicaid II Feasibility Study.

n.a. = not applicable.

Table F.MO.3. Estimates of the association between prenatal WIC participation and the primary outcome variables: Robustness checks for Missouri

Specification	Low birthweight (%) (1)	Very low birthweight (%) (2)	Small-for-gestational age (%) (3)	Neonatal mortality (deaths per 1,000) (4)	Breast-feeding at discharge (%) (5)	Lower than recommended weight gain during pregnancy (%) (6)	Higher than recommended weight gain during pregnancy (%) (7)	Medicaid costs from birth through 60 days postpartum ($)[a] (8)	Medicaid costs from the prenatal period through 60 days post-partum ($)[a] (9)
Primary specifications (reproduced from Chapter III to ease comparisons)									
1. Any WIC participation (IPW with gestational age)	-0.26 (0.28)	0.16*† (0.07)	0.38 (0.42)	0.64 (0.56)	1.86**† (0.67)	-1.18*† (0.53)	2.04**† (0.67)	-580*† (226)	-703**† (268)
2. First-trimester enrollees (IPW with gestational age)	-0.07 (0.39)	0.25* (0.10)	0.64 (0.54)	1.07 (0.78)	1.84* (0.88)	-0.73 (0.70)	2.31** (0.89)	-635* (305)	-675 (349)
Alternative matching variables									
3. IPW with prenatal care adequacy (APNCU-2M)	-0.15 (0.28)	0.15* (0.07)	0.52 (0.42)	0.66 (0.57)	1.14 (0.68)	-0.81 (0.54)	1.72* (0.69)	-645* (252)	-846** (293)
4. IPW with prenatal care adequacy (Kessner)	-0.18 (0.29)	0.15* (0.07)	0.46 (0.43)	0.68 (0.57)	1.09 (0.68)	-0.64 (0.53)	1.66* (0.69)	-666** (254)	-859** (293)
5. IPW without prenatal care from public clinic	-0.28 (0.27)	0.10 (0.07)	0.39 (0.39)	0.53 (0.55)	1.50* (0.62)	-1.30** (0.50)	2.36** (0.63)	-318 (192)	-68 (227)
6. IPW without SNAP enrollment	-0.17 (0.28)	0.16* (0.07)	0.42 (0.41)	0.18 (0.60)	1.57* (0.65)	-1.30* (0.53)	2.06** (0.66)	-531* (219)	-613* (263)
Alternative WIC participation measures (IPW, matched on gestational age)									
7. WIC participation measure includes enrollees without food instrument redemption	-0.26 (0.30)	0.13 (0.07)	0.27 (0.44)	0.60 (0.59)	1.19 (0.69)	-1.30* (0.56)	1.59* (0.70)	-729** (256)	-926** (303)
8. WIC participation as self-reported on BC	0.04 (0.34)	0.04 (0.09)	1.03* (0.48)	-0.73 (0.87)	0.42 (0.80)	-1.31* (0.65)	2.07* (0.81)	-512 (325)	-573 (405)
Alternative sample inclusion/exclusion criteria (IPW, matched on gestational age)									
9. Full-term births only[b]	-0.04 (0.20)	0.06** (0.02)	0.51 (0.50)	-0.03 (0.51)	1.42 (0.83)	-0.90 (0.65)	2.31** (0.85)	-246 (147)	-239 (191)
10. Early Medicaid enrollees only	0.36 (0.41)	0.03 (0.07)	0.68 (0.68)	0.39 (0.80)	0.36 (1.10)	-1.28 (0.89)	2.16 (1.10)	-822* (354)	-1,322** (429)
11. Exclude mother-only and infant-only observations	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-519* (222)	-635* (264)

Specification	Low birthweight (%) (1)	Very low birthweight (%) (2)	Small-for-gestational age (%) (3)	Neonatal mortality (deaths per 1,000) (4)	Breast-feeding at discharge (%) (5)	Lower than recommended weight gain during pregnancy (%) (6)	Higher than recommended weight gain during pregnancy (%) (7)	Medicaid costs from birth through 60 days postpartum ($)[a] (8)	Medicaid costs from the prenatal period through 60 days post-partum ($)[a] (9)
12. Drop observations where the infant died	-0.31	0.12	0.35	n.a.	1.85**	-1.22*	2.10**	-589**	-710**
	(0.28)	(0.06)	(0.42)		(0.67)	(0.53)	(0.68)	(217)	(261)
13. Include previously excluded Cherokee/ Potawatomi dyads (code as nonparticipants)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
14. Include previously excluded Cherokee/ Potawatomi dyads (code as participants)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Alternative specifications									
15. Regression adjustment (instead of IPW)	-0.25	0.10*	0.15	-0.04	1.68**	-1.55**	2.02**	-505**	-481*
	(0.24)	(0.05)	(0.37)	(0.52)	(0.57)	(0.47)	(0.58)	(187)	(214)
16. IPW plus regression adjustment (doubly robust estimator)	-0.07	0.12*	0.42	0.15	1.54*	-1.17*	2.34**	-529*[c]	-631*[c]
	(0.26)	(0.05)	(0.40)	(0.62)	(0.64)	(0.52)	(0.64)	(213)	(250)
17. Subclassification on the propensity score (10 subclasses)[d]	-0.46	--[e]	0.30	--[e]	1.78**	-1.27*	2.16**	-579*	-615*
	(0.33)		(0.41)		(0.67)	(0.52)	(0.67)	(247)	(288)
18. Subclassification on the propensity score (50 subclasses)[d]	-0.40	--[e]	0.31	--[e]	1.78**	-1.21*	2.14**	-602*	-658*
	(0.33)		(0.41)		(0.67)	(0.53)	(0.67)	(260)	(301)
19. Propensity score nearest neighbor matching	-0.43	0.11	0.23	1.01	1.17	-1.29	2.08*	-694*	-694
	(0.39)	(0.12)	(0.52)	(0.72)	(0.82)	(0.66)	(0.84)	(313)	(363)
20. Entropy balancing[f]	-0.39	0.15	0.40	0.77	1.72**	-1.23**	2.36**	-544**	-572**
	(0.27)	(0.10)	(0.32)	(0.55)	(0.53)	(0.41)	(0.53)	(179)	(203)
21. Minimum-biased estimator[g]	-0.85	0.17	0.14	-1.13	3.45*	-2.26*	0.81	-904	-819
	(0.82)	(0.39)	(0.83)	(1.91)	(1.44)	(1.12)	(1.44)	(515)	(557)
Imputing missing outcome data									
22. Multiple imputation with IPW	-0.25	0.17*[h]	0.39[h]	n.a.	1.82**[h]	-1.02[h]	1.92**[h]	-433**[i]	n.a.
	(0.28)	(0.07)	(0.42)		(0.66)	(0.56)	(0.67)	(130)	

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. Some observations were dropped, on a variable-by-variable basis, due to missing data. Refer to Appendix E, Table E.4 for sample sizes, by outcome, for the first row.

Outcomes are defined in Chapter III, Table III.3. The low birthweight and very low birthweight outcome measures are binary indicators of birthweight fewer than 2,500 g and fewer than 1,500 g, respectively. Small-for-gestational age infants had birthweights below the 10th percentile for gestational age based on race/ethnicity- and gender-

specific reference standards. Neonatal infant mortality includes infant deaths occurring fewer than 28 days after birth. Lower than [higher than] recommended weight gain during pregnancy are weight gains 10 percent or more below [above] the IOM recommendations.

The first row of the table presents the difference in the outcomes between a group of WIC participants and a corresponding matched comparison group of nonparticipants, where the matched comparison group was constructed with inverse probability weighting, as described in the text. The propensity score model included gestational age and the full set of covariates shown in Chapter III, Table III.4. The remaining rows of the table present variations on the primary model, with (1) alternative variables included in the propensity score model, (2) alternative WIC participation measures, or (3) alternative observations included in the analyses. The text in this appendix describes each specification/sample in more detail.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons. Note that, for comparability, the tests marked with daggers (†) are *not* adjusted for multiple comparisons in this table, although these tests *are* adjusted for multiple comparisons in Appendix E, Table E.7 and the figures in Chapter III.

[a] The analysis of Medicaid costs includes only fee-for-service recipients. Approximately 64 percent of Medicaid recipients in Missouri are enrolled in Medicaid managed care. Managed care claims in Missouri do not include information about actual costs of services.

[b] Sample was limited to births at 39, 40, or 41 completed weeks gestation.

[c] For Medicaid costs, the IPW and regression adjustment included dummies for gestational age.

[d] For details, see the footnotes to Appendix E, Table E.18.

[e] Models with subclassification on propensity score could not be estimated for the two outcomes, very low birthweight and neonatal mortality, because these outcomes are rare.

[f] For more details on this empirical approach, see Hainmueller (2012) and Hainmueller and Xu (2013).

[g] For more details on this empirical approach, see Millimet and Tchernis (2012) and McCarthy, Millimet, and Tchernis (2014). The parameter theta equals 0.10. The minimum-biased estimator uses only observations with a propensity score in a neighborhood around the bias-minimizing propensity score; it is not an average treatment effect on the treated.

[h] Birth certificate outcomes were imputed in this row. See Appendix E, Table E.4 for the fraction of dyads with missing data, by outcome. See the text in Appendix F, Section G for a description of the imputation approach.

[i] Medicaid costs beneficiaries were imputed for 22,989 managed care mother-infant dyads, and observed costs were used for 13,442 fee-for-service mother–infant dyads. See Appendix F, Section K for a description of the imputation approach.

APNCU = Adequacy of Prenatal Care Utilization; IOM = Institute of Medicine (now referred to as the National Academies of Science, Engineering and Medicine); IPW = inverse probability weighting; n.a. = not applicable; [SE = standard error; SNAP = Supplemental Nutrition Assistance Program; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table F.OK.3. Estimates of the association between prenatal WIC participation and the primary outcome variables: Robustness checks for Oklahoma

Specification	Low birthweight (%) (1)	Very low birthweight (%) (2)	Small-for-gestational age (%) (3)	Neonatal mortality (deaths per 1,000) (4)	Breast-feeding at discharge (%) (5)	Lower than recommended weight gain during pregnancy (%) (6)	Higher than recommended weight gain during pregnancy (%) (7)	Medicaid costs from birth through 60 days postpartum ($)[a] (8)	Medicaid costs from the prenatal period through 60 days postpartum ($)[a] (9)
Primary specifications (reproduced from Chapter III to ease comparisons)									
1. Any WIC participation (IPW with gestational age)	-0.60	-0.11	-0.49	0.38	1.59*†	-3.15**†	2.40**†	54	424**†
	(0.32)	(0.09)	(0.47)	(0.69)	(0.66)	(0.62)	(0.71)	(115)	(132)
2. First-trimester enrollees (IPW with gestational age)	-1.25**	-0.26	-0.74	0.08	1.54	-3.85**	3.42**	18	599**
	(0.43)	(0.13)	(0.58)	(0.96)	(0.82)	(0.75)	(0.87)	(171)	(195)
Alternative matching variables									
3. IPW with prenatal care adequacy (APNCU-2M)	-0.53	-0.07	-0.20	0.59	0.71	-2.46**	1.71*	84	393**
	(0.33)	(0.08)	(0.47)	(0.67)	(0.67)	(0.62)	(0.73)	(110)	(128)
4. IPW with prenatal care adequacy (Kessner)	-0.56	-0.08	-0.25	0.53	0.53	-2.31**	1.67*	65	362**
	(0.33)	(0.09)	(0.47)	(0.68)	(0.66)	(0.62)	(0.72)	(114)	(132)
5. IPW without prenatal care from public clinic	-0.57	-0.10	-0.40	0.38	1.91**	-3.37**	2.66**	101	564**
	(0.31)	(0.09)	(0.46)	(0.70)	(0.65)	(0.61)	(0.70)	(112)	(125)
6. IPW without SNAP enrollment	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Alternative WIC participation measures (IPW, matched on gestational age)									
7. WIC participation measure includes enrollees without food instrument redemption	-0.30	-0.08	-0.01	0.29	1.30	-2.95**	2.10**	-71	315*
	(0.32)	(0.09)	(0.48)	(0.73)	(0.68)	(0.64)	(0.73)	(124)	(137)
8. WIC participation as self-reported on BC	-0.28	-0.15	-0.06	0.27	2.24**	-2.82**	2.15**	61	437**
	(0.34)	(0.11)	(0.49)	(0.79)	(0.73)	(0.68)	(0.76)	(131)	(153)
Alternative sample inclusion/exclusion criteria (IPW, matched on gestational age)									
9. Full-term births only[b]	-0.42	-0.01	-0.40	-0.60	1.15	-3.11**	2.80**	121	436**
	(0.28)	(0.05)	(0.63)	(0.64)	(0.87)	(0.81)	(0.95)	(92)	(124)
10. Early Medicaid enrollees only	0.16	0.10	0.45	0.68	0.57	-2.17	1.62	143	147
	(0.57)	(0.06)	(0.97)	(0.78)	(1.44)	(1.31)	(1.53)	(154)	(205)
11. Exclude mother-only and infant-only observations	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	40	401**
								(127)	(146)

Specification	Low birthweight (%) (1)	Very low birthweight (%) (2)	Small-for-gestational age (%) (3)	Neonatal mortality (deaths per 1,000) (4)	Breast-feeding at discharge (%) (5)	Lower than recommended weight gain during pregnancy (%) (6)	Higher than recommended weight gain during pregnancy (%) (7)	Medicaid costs from birth through 60 days postpartum ($)[a] (8)	Medicaid costs from the prenatal period through 60 days postpartum ($)[a] (9)
12. Drop observations where the infant died	-0.52	-0.11	-0.43	n.a.	1.60*	-3.16**	2.49**	83	451**
	(0.32)	(0.08)	(0.47)		(0.66)	(0.62)	(0.71)	(105)	(123)
13. Include previously excluded Cherokee/ Potawatomi dyads (code as nonparticipants)	-0.36	-0.10	-0.29	0.31	2.79**	-2.69**	1.89**	76	405**
	(0.30)	(0.08)	(0.44)	(0.70)	(0.62)	(0.57)	(0.67)	(108)	(122)
14. Include previously excluded Cherokee/ Potawatomi dyads (code as participants)	-0.65*	-0.10	-0.56	0.32	1.17	-3.18**	2.52**	50	421**
	(0.32)	(0.09)	(0.47)	(0.71)	(0.66)	(0.62)	(0.71)	(115)	(132)
Alternative specifications									
15. Regression adjustment (instead of IPW)	-0.02	-0.09	-0.25	0.51	2.01**	-2.93**	2.49**	55	432**
	(0.26)	(0.07)	(0.42)	(0.66)	(0.60)	(0.56)	(0.64)	(112)	(123)
16. IPW plus regression adjustment (doubly robust estimator)	-0.28	-0.12	-0.49	0.50	1.61*	-3.04**	2.32**	98 [c]	470** [c]
	(0.29)	(0.08)	(0.46)	(0.70)	(0.66)	(0.62)	(0.70)	(103)	(121)
17. Subclassification on the propensity score (10 subclasses)[d]	-0.68	--[e]	-0.36	--[e]	1.51*	-3.17**	2.38**	46	467**
	(0.37)		(0.47)		(0.69)	(0.63)	(0.73)	(127)	(142)
18. Subclassification on the propensity score (50 subclasses)[d]	-0.57	--[e]	-0.43	--[e]	1.52*	-3.13**	2.39**	51	458**
	(0.37)		(0.47)		(0.69)	(0.63)	(0.73)	(129)	(144)
19. Propensity score nearest neighbor matching	-0.57	-0.19	-0.57	0.00	2.12*	-3.26**	1.80*	-14	375*
	(0.44)	(0.12)	(0.63)	(0.84)	(0.86)	(0.78)	(0.91)	(144)	(162)
20. Entropy balancing[f]	-0.46	-0.08	-0.53	0.56	1.81**	-3.04**	2.32**	45	408**
	(0.30)	(0.12)	(0.36)	(0.64)	(0.54)	(0.48)	(0.57)	(103)	(115)
21. Minimum-biased estimator[g]	-0.43	-0.66	-1.73	-1.40	5.33**	-3.57*	2.17	-210	-4
	(0.95)	(0.49)	(0.99)	(2.93)	(1.58)	(1.44)	(1.66)	(365)	(409)
Imputing missing outcome data									
22. Multiple imputation with IPW	-0.59[h]	-0.11[h]	-0.50[h]	n.a.	1.59*[h]	-2.98**[h]	2.22**[h]	n.a.	n.a.
	(0.33)	(0.09)	(0.47)		(0.66)	(0.62)	(0.71)		

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate. Some observations were dropped, on a variable-by-variable basis, due to missing data. Refer to Appendix E, Table E.4 for sample sizes, by outcome, for the first row.

Outcomes are defined in Chapter III, Table III.3. The low birthweight and very low birthweight outcome measures are binary indicators of birthweight fewer than 2,500 g and fewer than 1,500 g, respectively. Small-for-gestational age infants had birthweights below the 10th percentile for gestational age based on race/ethnicity- and gender-

specific reference standards. Neonatal infant mortality includes infant deaths occurring fewer than 28 days after birth. Lower than [higher than] recommended weight gain during pregnancy are weight gains 10 percent or more below [above] the IOM recommendations.

The first row of the table presents the difference in the outcomes between a group of WIC participants and a corresponding matched comparison group of nonparticipants, where the matched comparison group was constructed with inverse probability weighting, as described in the text. The propensity score model included gestational age and the full set of covariates shown in Chapter III, Table III.4. The remaining rows of the table present variations on the primary model, with (1) alternative variables included in the propensity score model, (2) alternative WIC participation measures, or (3) alternative observations included in the analyses. The text in this appendix page describes each specification/sample in more detail.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons. Note that, for comparability, the tests marked with dags ([†]) are *not* adjusted for multiple comparisons in this table, although these tests *are* adjusted for multiple comparisons in Appendix E, Table E.7 and the figures in the report.

[a] The analysis of Medicaid costs excludes Native Americans. Oklahoma Medicaid did not provide cost data for Native Americans because many of these individuals receive care through the IHS, and IHS providers do not necessarily report all services and costs to Oklahoma Medicaid.

[b] Sample was limited to births at 39, 40, or 41 completed weeks gestation.

[c] For Medicaid costs, the IPW and regression adjustment included dummies for gestational age.

[d] For details, see the footnotes to Appendix E, Table E.18.

[e] Models with subclassification on propensity score could not be estimated for the two outcomes, very low birthweight and neonatal mortality, because these outcomes are rare.

[f] For more details on this empirical approach, see Hainmueller (2012) and Hainmueller and Xu (2013).

[g] For more details on this empirical approach, see Millimet and Tchernis (2012) and McCarthy, Millimet, and Tchernis (2014). The parameter theta equals 0.10. The minimum-biased estimator uses only observations with a propensity score in a neighborhood around the bias-minimizing propensity score; it is not an average treatment effect on the treated.

[h] Birth certificate outcomes were imputed in this row. See Appendix E, Table E.4 for the fraction of dyads with missing data, by outcome. See the text in Appendix F, Section G for a description of the imputation approach.

APNCU = Adequacy of Prenatal Care Utilization; IHS = Indian Health Service; IOM = Institute of Medicine (now referred to as the National Academies of Science, Engineering and Medicine); IPW = inverse probability weighting; n.a. = not applicable; SE = standard error; SNAP = Supplemental Nutrition Assistance Program.

Table F.MO.4. Estimates of the association between any prenatal WIC participation and alternative measures of Medicaid costs for Missouri

Outcome	WIC participants (1)	Matched comparison group (2)	Difference (SE) (3)	Effect size (4)	Sample size (5)
Medicaid costs: Did not prorate claims with end dates later than 60 days after birth					
Medicaid costs for newborn and mother from birth through 60 days postpartum ($, not prorated)	6,799	7,462	-663* (264)	-0.054	13,779
Medicaid costs for newborn and mother from the prenatal period through 60 days postpartum ($, not prorated)	10,196	10,982	-785** (300)	-0.058	13,779
Medicaid costs for newborn (only) from birth through 60 days postpartum ($, not prorated)	4,152	4,699	-547* (251)	-0.047	13,779
Medicaid costs for mother (only) from the prenatal period through 60 days postpartum ($, not prorated)	6,045	6,284	-239 (135)	-0.043	13,779
Transformed Medicaid costs for mother and newborn from birth through 60 days postpartum					
Winsorized (trimmed) at $100,000	6,585	7,191	-606** (213)	-0.064	13,779
Winsorized at $75,000	6,486	7,090	-604** (198)	-0.070	13,779
Winsorized at $50,000	6,282	6,872	-590** (177)	-0.082	13,779
Logarithm of costs[a]	8.42	8.48	-0.06** (0.02)	-0.061	13,779

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. Some observations were dropped, on a variable-by-variable basis, due to missing data.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in the text, where the propensity score model included gestational age and the full set of covariates shown in Chapter III, Table III.4.

The analysis of Medicaid costs includes only fee-for-service recipients. Approximately 64 percent of Medicaid recipients in Missouri are enrolled in Medicaid managed care. Managed care claims in Missouri do not include information about actual costs of services.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

[a] The outcome variable was the logarithm of Medicaid costs for newborn and mother from birth through 60 days postpartum plus $0.01.

SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table F.OK.4. Estimates of the association between any prenatal WIC participation and alternative measures of Medicaid costs for Oklahoma

Outcome	WIC participants (1)	Matched comparison group (2)	Difference (SE) (3)	Effect size (4)	Sample size (5)
Medicaid costs: Did not prorate claims with end dates later than 60 days after birth					
Medicaid costs for newborn and mother from birth through 60 days postpartum ($, not prorated)	5,741	5,710	31 (120)	0.004	25,419
Medicaid costs for newborn and mother from the prenatal period through 60 days postpartum ($, not prorated)	9,392	8,992	400** (136)	0.042	25,419
Medicaid costs for newborn (only) from birth through 60 days postpartum ($, not prorated)	2,817	2,870	-53 (113)	-0.006	25,419
Medicaid costs for mother (only) from the prenatal period through 60 days postpartum ($, not prorated)	6,575	6,122	453** (64)	0.118	25,419
Transformed Medicaid costs for mother and newborn from birth through 60 days postpartum					
Winsorized (trimmed) at $100,000	5,673	5,501	172 (106)	0.022	25,419
Winsorized at $75,000	5,623	5,450	174 (99)	0.024	25,419
Winsorized at $50,000	5,504	5,315	189* (84)	0.030	25,419
Logarithm of costs[a]	8.25	8.12	0.13** (0.02)	0.097	25,419

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate. Some observations were dropped, on a variable-by-variable basis, due to missing data.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in the text, where the propensity score model included gestational age and the full set of covariates shown in Chapter III, Table III.4.

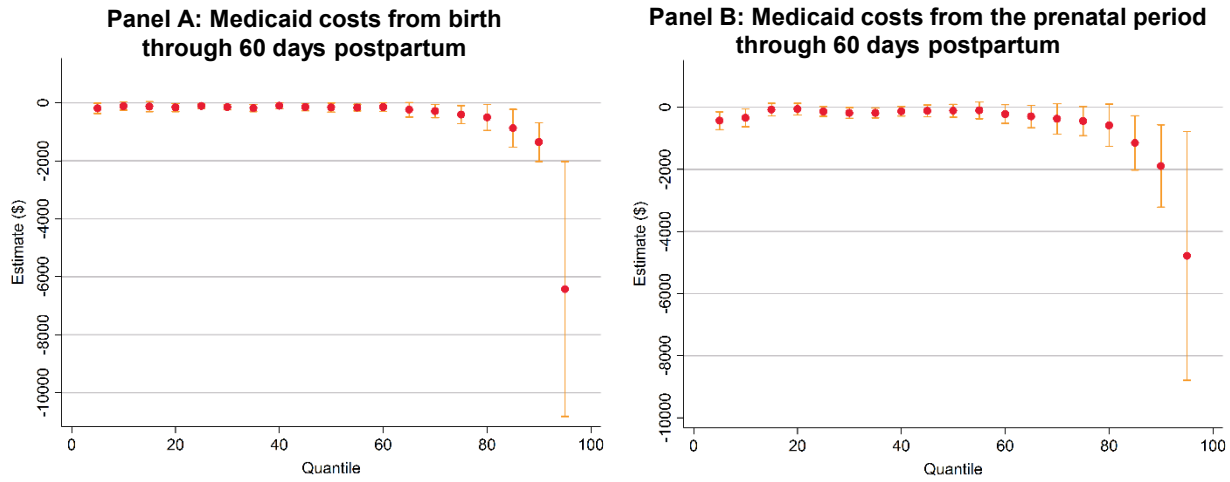
The analysis of Medicaid costs in Oklahoma excludes Native Americans. Oklahoma Medicaid did not provide cost data for Native Americans because many of them receive care through the IHS. IHS providers do not necessarily report all services and costs to Oklahoma Medicaid. Refer to Appendix E, Table E.4 for sample sizes. The outcome measure is defined in Chapter III, Table III.3.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

[a] The outcome variable was the logarithm of Medicaid costs for newborn and mother from birth through 60 days postpartum plus $0.01.

IHS = Indian Health Service; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Figure F.MO.1. Estimates of the association between any WIC participation and Medicaid costs, by quantile



Source: WM-II databases for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. Refer to Appendix E, Table E.4 for sample sizes. The outcome measure, defined in Table II.5, includes Medicaid costs for the mother and infant during the prenatal period, birth/delivery, and first 60 days postpartum.

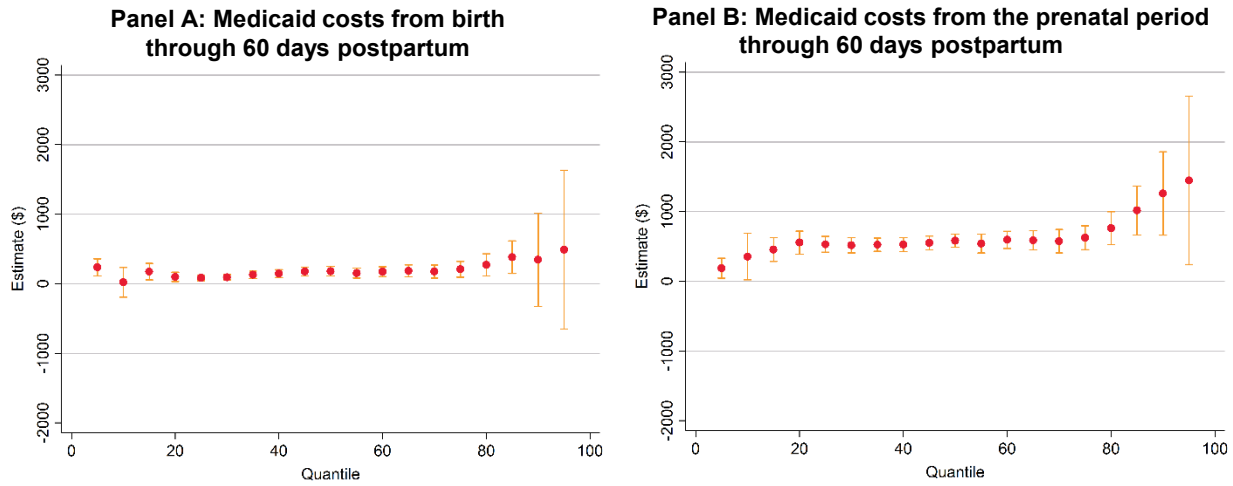
This figure presents the results from a quantile treatment effects model using methods from Bitler et al. (2006). The WIC participants are compared, by quantile, to a matched comparison group of nonparticipants. The matched comparison group was constructed with inverse probability weighting, as described in the text, where the propensity score model included gestational age and the full set of covariates shown in Chapter III, Table III.4. Results were similar to this figure when the methods from Cattaneo et al. (2013) were used.

The 95 percent confidence intervals are based on 500 bootstrapped iterations. An estimate greater than zero indicates that WIC participants (at a specific quantile) had higher costs than the matched comparison group of nonparticipants, and a negative association indicates WIC participants had lower costs than nonparticipants (at the same quantile).

The analysis of Medicaid costs in Missouri includes only fee-for-service recipients. Approximately 64 percent of Medicaid recipients in Missouri receive care through Medicaid managed care plans. Medicaid managed care claims in Missouri do not include information about actual costs of services.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Figure F.OK.1. Estimates of the association between any WIC participation and Medicaid costs, by quantile



Source: WM-II databases for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate. Refer to Appendix E, Table E.4 for sample sizes. The outcome measure, defined in Chapter III, Table III.3, includes Medicaid costs for the mother and infant during the prenatal period, birth/delivery, and first 60 days postpartum.

This figure presents the results from a quantile treatment effects model using methods from Bitler et al. (2006). The WIC participants are compared, by quantile, to a matched comparison group of nonparticipants. The matched comparison group was constructed with inverse probability weighting, as described in the text, where the propensity score model included gestational age and the full set of covariates shown in Chapter III, Table III.4. Results were similar to this figure when the methods from Cattaneo et al. (2013) were used.

The 95 percent confidence intervals are based on 500 bootstrapped iterations. An estimate greater than zero indicates that WIC participants (at a specific quantile) had higher costs than the matched comparison group of nonparticipants, and a negative association indicates WIC participants had lower costs than nonparticipants (at the same quantile).

The analysis of Medicaid costs in Oklahoma excludes Native Americans. Oklahoma Medicaid did not provide cost data for Native Americans because many of these individuals receive care through the IHS, whose providers do not necessarily report all services and costs to Oklahoma Medicaid.

IHS = Indian Health Service; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table F.MO.5. Comparison of mothers and infants in Medicaid managed care in Missouri to mothers and infants in fee-for-service Medicaid

Characteristic	Fee-for-service (included in analyses of Medicaid costs)	Managed care (excluded from analyses of Medicaid costs)
Mother's characteristics		
Age		
17 years or younger	4.87	5.05
18 or 19 years	12.89	13.40
20–-34 years	76.83	76.34
35 years or older	5.41	5.22
Race/ethnicity		
Hispanic	13.33	4.51††
Non-Hispanic white	73.92	58.48
Non-Hispanic black	6.84	31.21
Non-Hispanic American Indian Alaskan Native	0.37	0.22
Non-Hispanic Asian Pacific Islander	1.84	1.16
Non-Hispanic other race	0.31	0.48
Non-Hispanic multi-race	2.61	3.38
Race/ethnicity unknown	0.77	0.56
Foreign-born	14.82	5.69**
Married	41.64	27.72**
Education		
Less than high school	32.31	26.59††
High school graduate or GED	35.02	35.90
Some college, no degree	27.71	32.62
College degree	4.96	4.90
Rural residence	53.88	25.27**
Prenatal care from public clinic	59.06	18.89**
Family income less than 100 percent of FPL	86.33	88.12**
Mean household income (percentage of FPL)	27.45	32.78**
SNAP enrollment (mother)	60.18	73.39**
SNAP enrollment (infant)	39.37	45.04**
TANF enrollment (mother)	14.86	22.07**
Aged, blind, and/or disabled Medicaid enrollment (mother)	3.79	2.17**
Newborn's characteristics		
Infant's gender is male	51.76	51.32

Characteristic	Fee-for-service (included in analyses of Medicaid costs)	Managed care (excluded from analyses of Medicaid costs)
Pregnancy risk factors		
Pre-pregnancy BMI		
Less than 18.5 (underweight)	5.93	5.22††
18.5 to 24.9 (normal)	43.02	43.41
25 to 29.9 (overweight)	22.49	22.82
30 to 40.4 (obese)	20.02	20.91
40.5 or more (extremely obese)	5.12	5.93
Unknown	3.41	1.72
Smoked three months before pregnancy	37.19	37.41
Number of cigarettes/day before pregnancy	6.29	6.56*
Previous Cesarean delivery	11.90	12.42
Previous preterm birth	3.37	3.70
Previous other poor birth outcomes	1.85	1.81
Pre-pregnancy diabetes	0.91	0.92
Pre-pregnancy hypertension	1.24	1.74**
Pregnancy history		
Inter-pregnancy interval		
First birth	33.45	34.08††
≥18 months	28.94	30.46
Short (6-17 months)	16.14	16.08
Very short (<6 months)	7.95	8.31
Unknown	13.52	11.07
Number of previous live births (mean)	1.14	1.16
Any previous terminations	24.60	28.03**
Sample size	13,779	24,058
Percentage with mother's record(s) in Medicaid files	98.72	97.34**
Percentage with infant's record(s) in Medicaid files	98.84	98.22**

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate.

The table presents the percentage of observations for binary and categorical variables, and it presents means for continuous variables. Variables are defined in Chapter III, Table III.4. Asterisks denote statistically significant differences between WIC participants and nonparticipants from Student's t-tests for dichotomous and continuous variables (* $p < 0.05$; ** $p < 0.01$) and daggers (†) denote statistically significant chi-squared tests for categorical variables († $p < 0.05$; †† $p < 0.01$). Percentages across categories may not total 100 percent because of rounding and missing data.

BMI = body mass index; FPL = Federal poverty level; GED = general education development degree; SNAP = Supplemental Nutrition Assistance Program; TANF = Temporary Assistance for Needy Families; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table F.MO.6. Estimates of the association between any prenatal WIC participation and the primary outcomes in Missouri, by managed care or fee-for-service enrollment

Outcome	Fee-for-service (included in analyses of Medicaid costs) (1)	Managed care (excluded from analyses of Medicaid costs) (2)
Birth outcomes		
Low birthweight (%)	-0.04	-0.09
	(0.44)	(0.30)
Very low birthweight (%)	0.14	0.14
	(0.11)	(0.08)
Small-for-gestational age (%)	0.80	0.56
	(0.67)	(0.46)
Neonatal mortality (deaths per 1,000)	0.12	0.65
	(0.91)	(0.70)
Maternal behaviors		
Breastfeeding at discharge (%)	0.85	1.55*
	(1.07)	(0.74)
Maternal health		
Had lower than recommended weight gain during pregnancy (%)	0.49	-2.04**
	(0.86)	(0.58)
Had higher than recommended weight gain during pregnancy (%)	0.68	3.20**
	(1.08)	(0.73)
Sample size[a]	13,779	24,058

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. The last row indicates the potential number of mother-infant dyads in the analysis, although, for some outcomes, observations were dropped on a variable-by-variable basis due to missing data. Refer to Appendix E, Table E.4 for sample sizes, by outcome. Three observations were dropped from the analyses because of missing data for rural residence and number of prior live births.

Outcomes are defined in Chapter III, Table III.3. The low birthweight and very low birthweight outcome measures are binary indicators of birthweight fewer than 2,500 g and fewer than 1,500 g, respectively. Small-for-gestational age infants had birthweights below the 10th percentile for gestational age based on race/ethnicity- and gender-specific reference standards. Neonatal infant mortality includes infant deaths occurring less than 28 days after birth. Lower than [higher than] recommended weight gain during pregnancy are weight gains 10 percent or more below [above] the IOM recommendations.

Each column presents the difference in the outcomes between a group of WIC participants and a corresponding matched comparison group of nonparticipants, where the matched comparison group was constructed with inverse probability weighting, as described in the text. The propensity score model included gestational age and the full set of covariates shown in Chapter III, Table III.4 (with a few minor exceptions when small samples for certain subgroups did not permit the inclusion of rare characteristics). Models were estimated separately for each subgroup.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

IOM = Institute of Medicine (now referred to as the National Academies of Science, Engineering and Medicine); WM-II = WIC-Medicaid II Feasibility Study.

Table F.MO.7. Estimates of the association between any prenatal WIC participation and measures of health care utilization outcomes in Missouri, by managed care or fee-for-service enrollment

Outcome	Fee-for-service (included in analyses of Medicaid costs) (1)	Managed care (excluded from analyses of Medicaid costs) (2)
Mother's utilization of prenatal and labor and delivery health care services		
Number of hospitalizations	-0.03*	-0.01
	(0.01)	(0.01)
Number of days in a hospital	-0.20*	-0.17**
	(0.08)	(0.04)
Length of hospital stay for delivery (number of days)	-0.10*	-0.09**
	(0.04)	(0.03)
Any ICU admission at delivery (%)	-0.04	-0.08
	(0.17)	(0.12)
Number of days in an ICU at delivery	-0.01	-0.01
	(0.02)	(0.01)
Number of office visits	0.24	0.80**
	(0.14)	(0.07)
Number of emergency department visits	-0.09*	0.08**
	(0.04)	(0.02)
Mother's utilization of postpartum health care services up to 60 days postpartum		
Number of hospitalizations (postpartum)	-0.01	-0.00
	(0.00)	(0.00)
Number of days in a hospital (postpartum)	-0.04	0.01
	(0.02)	(0.01)
Postpartum care visit (% with visit 21-56 days after delivery)	2.70*	6.62**
	(1.14)	(0.76)
Number of office visits	0.02	0.13**
	(0.02)	(0.01)
Number of emergency department visits	-0.02	0.01
	(0.01)	(0.01)
Infant's health care utilization up to 60 days after birth		
Length of hospital stay for birth (number of days)[a]	-0.21*	-0.09
	(0.10)	(0.07)
Any NICU admission (%, NICU levels 3 or 4)	-1.95**	-0.08
	(0.66)	(0.38)
Hospitalizations with Level 3 NICU admission: Number of days	-0.19	-0.07
	(0.10)	(0.06)
Hospitalizations with Level 4 NICU admission: Number of days	-0.11	-0.06
	(0.10)	(0.05)
Number of hospitalizations (total)	0.01	0.02*
	(0.01)	(0.01)

Outcome	Fee-for-service (included in analyses of Medicaid costs) (1)	Managed care (excluded from analyses of Medicaid costs) (2)
Number of days in a hospital (total)	-0.11	-0.12
	(0.10)	(0.07)
Number of office visits (well- or sick-infant)	0.27*	0.18**
	(0.11)	(0.04)
Number of well-infant office visits (EPSDT and other preventive care)	0.29**	0.29**
	(0.03)	(0.02)
Number of EPSDT visits	0.25**	0.29**
	(0.03)	(0.02)
Number of sick-infant (other) office visits	-0.01	-0.10**
	(0.10)	(0.04)
Number of emergency department visits	0.01	0.02**
	(0.01)	(0.01)
Sample size	**13,779**	**24,058**

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. The last row indicates the potential number of mother-infant dyads in the analysis, although, for some outcomes, observations were dropped on a variable-by-variable basis due to missing data. Refer to Appendix E, Table E.4 for sample sizes, by outcome. Outcomes are defined in Chapter III, Table III.3.

Each column presents the difference in the outcomes between a group of WIC participants and a corresponding matched comparison group of nonparticipants, where the matched comparison group was constructed with inverse probability weighting, as described in the text. The propensity score model included gestational age and the full set of covariates shown in Chapter III, Table III.4 (with a few minor exceptions when small samples for certain subgroups did not permit the inclusion of rare characteristics). Models were estimated separately for each subgroup.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

[a] Number of unique days in the hospital associated with one or more inpatient claims that included Level 3/Level 4 revenue center charge codes.

EPSDT = Early Periodic Screening and Diagnosis and Treatment; ICU = intensive care unit; NICU = neonatal intensive care unit; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM –II = WIC-Medicaid II Feasibility Study.

Table F.OK.8. Comparison of Native American mothers and infants to mothers and infants of other races in Oklahoma

Characteristic	Non-Native American (included in analyses of Medicaid costs and utilization)	Native American (excluded from analyses of Medicaid costs and utilization)
Mother's characteristics		
Age		
17 years or younger	5.37	6.40††
18 or 19 years	12.31	14.10
20–34 years	76.38	75.83
35 years or older	5.94	3.67
Race/ethnicity		
Hispanic	21.18	4.67††
Non-Hispanic white	59.37	24.61
Non-Hispanic black	12.68	1.48
Non-Hispanic American Indian Alaskan Native[a]	1.14	55.20
Non-Hispanic Asian Pacific Islander	2.33	0.11
Non-Hispanic other race	0.30	0.02
Non-Hispanic multi-race	2.99	13.91
Foreign-born	17.95	1.01**
Married	40.34	36.86**
Education		
Less than high school	32.46	28.37††
High school graduate or GED	34.90	38.32
Some college, no degree	27.86	29.75
College degree	4.51	3.34
Unknown	0.27	0.21
Rural residence	38.47	60.12**
Prenatal care from public clinic	11.11	2.64**
Family income less than 100 percent of FPL	80.69	80.20
Mean household income (percentage of FPL)	52.64	51.66
TANF enrollment (mother)	18.94	22.12**
Aged, blind, and/or disabled Medicaid enrollment (mother)	0.48	0.38
Newborn's characteristics		
Infant's gender is male	51.31	50.81

Characteristic	Non-Native American (included in analyses of Medicaid costs and utilization)	Native American (excluded from analyses of Medicaid costs and utilization)
Pregnancy risk factor		
Pre-pregnancy BMI		
Less than 18.5 (underweight)	5.39	4.47††
18.5 to 24.9 (normal)	42.97	39.65
25 to 29.9 (overweight)	24.18	24.78
30 to 40.4 (obese)	20.83	23.26
40.5 or more (extremely obese)	5.28	6.86
Unknown	1.35	0.99
Smoked three months before pregnancy	15.46	19.74**
Number of cigarettes/day before pregnancy	2.07	1.84**
Previous Cesarean delivery	14.51	15.81*
Previous preterm birth	2.15	2.41
Previous other poor birth outcomes	1.38	1.41
Pre-pregnancy diabetes	0.72	1.18**
Pre-pregnancy hypertension	1.30	2.01**
Pregnancy history		
Inter-pregnancy interval		
First birth	34.04	34.43††
≥18 months	34.82	32.91
Short (6-17 months)	16.95	18.37
Very short (<6 months)	8.43	9.23
Unknown	5.76	5.05
Number of previous live births (mean)	1.20	1.19
Any previous terminations	20.17	20.81
Sample size	25,419	5,263
Percentage with mother's record(s) in Medicaid files	97.57	97.32
Percentage with infant's record(s) in Medicaid files	89.02	88.87

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate.

The table presents the percentage of observations for binary and categorical variables, and it presents means for continuous variables. Variables are defined in Chapter III, Table III.4. Asterisks denote statistically significant differences between WIC participants and nonparticipants from Student's t-tests for dichotomous and continuous variables (*$p < 0.05$; ** $p < 0.01$) and daggers (†) denote statistically significant chi-squared tests for categorical variables († $p < 0.05$; †† $p < 0.01$). Percentages across categories may not total 100 percent because of rounding and missing data.

[a] The Native American race variable used to sort data in the two columns comes from the Medicaid data. There are discrepancies between the Medicaid data and the mother's race reported on the birth certificate.

BMI = body mass index; FPL = Federal poverty level; GED = general education development degree; TANF = Temporary Assistance for Needy Families; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM –II = WIC-Medicaid II Feasibility Study.

Table F.OK.9. Estimates of the association between any prenatal WIC participation and the primary outcomes in Oklahoma, by Native American and Non-Native American race

Outcome	Race	
	Non-Native American (included in analyses of Medicaid costs and utilization) (1)	Native American (excluded from analyses of Medicaid costs and utilization) (2)
Birth outcomes		
Low birthweight (%)	-0.36	-0.31
	(0.32)	(0.65)
Very low birthweight (%)	-0.06	-0.18
	(0.09)	(0.18)
Small-for-gestational age (%)	-0.12	-0.25
	(0.48)	(0.95)
Neonatal mortality (deaths per 1,000)	0.99	-1.45
	(0.64)	(2.01)
Maternal behaviors		
Breastfeeding at discharge (%)	2.65**	5.37**
	(0.72)	(1.56)
Maternal health		
Had lower than recommended weight gain during pregnancy (%)	-2.86**	-3.98**
	(0.66)	(1.32)
Had higher than recommended weight gain during pregnancy (%)	2.57**	4.39**
	(0.75)	(1.57)
Sample size	**25,419**	**5,263**

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate. The last row indicates the potential number of mother–infant dyads in the analysis, although, for some outcomes, observations were dropped on a variable-by-variable basis due to missing data. Refer to Appendix E, Table E.4 for sample sizes, by outcome. Three observations were dropped from the analyses because of missing data for rural residence and number of prior live births.

Outcomes are defined in Chapter III, Table III.3. The low birthweight and very low birthweight outcome measures are binary indicators of birthweight fewer than 2,500 g and fewer than 1,500 g, respectively. Small-for-gestational age infants had birthweights below the 10th percentile for gestational age based on race/ethnicity- and gender-specific reference standards. Neonatal infant mortality includes infant deaths occurring less than 28 days after birth. Lower than [higher than] recommended weight gain during pregnancy are weight gains 10 percent or more below [above] the IOM recommendations.

Each column presents the difference in the outcomes between a group of WIC participants and a corresponding matched comparison group of nonparticipants, where the matched comparison group was constructed with inverse probability weighting, as described in the text. The propensity score model included gestational age and the full set of covariates shown in Chapter III, Table III.4 (with a few minor exceptions when small samples for certain subgroups did not permit the inclusion of rare characteristics). Models were estimated separately for each subgroup.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

IOM = Institute of Medicine (now referred to as the National Academies of Science, Engineering and Medicine); WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM –II = WIC-Medicaid II Feasibility Study.

Table F.10. Estimates of the association between prenatal WIC participation and the primary outcome variables: Comparing the model specifications in WIC-Medicaid I and II

Specification	Medicaid costs for mother and infant, birth/delivery through 60 days ($)		Birthweight (in grams)	
	Missouri[a] (1)	Oklahoma[b] (2)	Missouri (3)	Oklahoma (4)
WM-II main findings				
WM-II methods (without multiple comparisons adjustment)	-580	54	1.02	9.98
	(226)* †	(115)	(5.95)	(6.49)
Alternative specifications				
1. WM-I methods [c,d,e,f,g]	-730	-271	48.81	43.07
	(245)**	(143)	(6.55)**	(7.44)**
2. WM-I methods, but control for gestational age [c,d,f,g]	-360	165	14.75	9.25
	(199)	(120)	(4.78)**	(5.54)
3. WM-II methods, but do not include gestational age in the propensity score model [e]	-1,071	-391	32.83	46.78
	(298)**	(160)*	(7.45)**	(8.50)**
4. WM-II methods, but use regression adjustment (not IPW) [c]	-505	55	9.58	7.24
	(187)**	(112)	(4.77)*	(5.55)
5. WM-II methods, but use only matching variables from WM-I [d]	-299	129	10.46	17.77
	(192)	(106)	(5.48)	(6.20)**
6. WM-II methods, but include prenatal care adequacy as a matching variable [f]	-666	65	-0.05	5.37
	(254)**	(114)	(6.05)	(6.67)
7. WM-II methods, but include multiple births in the sample [g]	-490	102	2.15	11.57
	(227)*	(118)	(6.00)	(6.40)

Sources: WM-II database for Missouri and Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 and in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate. Some observations were dropped, on a variable-by-variable basis, because of missing data. Refer to Appendix E, Table E.4 for sample sizes, by outcome, for the first row.

Outcomes are defined in Chapter III, Table III.3. The measure of Medicaid costs excludes costs for the mother from the prenatal period and physician costs associated with the birth or delivery (consistent with WM-I).

The first row of the table presents the difference in the outcomes between a group of WIC participants and a corresponding matched comparison group of nonparticipants. The matched comparison group was constructed with IPW, as described in the text. The propensity score model included gestational age and the full set of covariates shown in Chapter III, Table III.4. The remaining rows of the table present variations on the primary model using research methods more similar to the specifications from WM-I. The text on the previous page describes each specification/sample in more detail.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < 0.01$ (**) and $p < 0.05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons. Note that, for comparability, the tests marked with daggers (†) are *not* adjusted for multiple comparisons in this table, although these tests *are* adjusted for multiple comparisons in Appendix E, Table E.7 and the figures in the report.

[a] The analysis of Medicaid costs includes only fee-for-service recipients. About 64 percent of Medicaid recipients in Missouri are enrolled in Medicaid Managed Care. Managed care claims in Missouri do not include information about actual costs of services.

[b] The analysis of Medicaid costs excludes Native Americans. Oklahoma Medicaid did not provide cost data for Native Americans, because many of them receive care through the IHS, and IHS providers do not necessarily report all services and costs to Oklahoma Medicaid.

[c] In rows 1, 2, and 4, linear regression models (ordinary least squares) were used in place of IPW.

[d] Control variables (or matching variables) include the following: male newborn, mother's age (≤ 17, 18 or 19, 20–34, or ≥ 35 years), mother's race (Hispanic, *non-Hispanic white*, non-Hispanic black, non-Hispanic American/Indian Alaskan Native, non-Hispanic Asian Pacific Islander, or other/multiple races), married, number of previous live births and number of previous other birth outcomes (set to zero when number was unknown), mother's education (less than high school, high school graduate or GED, *some college or college graduate*, or unknown), rural residence, and prenatal care from a public clinic. Italics indicate the reference categories. Footnotes e, f, and g indicate whether gestational age, prenatal care adequacy, or a multiple birth dummy were also included as control variables (or matching variables). Note that, because of data limitations, in WM-I not all these controls were included in all five States.

[e] In rows 1 and 3, gestational age is not included as a control variable (or matching variable).

[f] In rows 1, 2, and 6, prenatal care adequacy is included as a control variable (or matching variable). Specifically, indicators for intermediate, inadequate, or unknown prenatal care (Kessner index) are included as a control variable (or matching variables).

[g] In rows 1, 2, and 7, multiple births were included in the sample. For these rows, the unit of observation is the delivery in columns 1 and 2, and the unit of observation is the newborn in the remaining columns. A dummy variable for multiple births is included as a control variable (or matching variable). For Medicaid costs, the male control variable equals 1 if at least one newborn was male and the WM-II control variables from the two to four records were combined.

GED = general educational development (diploma); IHS = Indian Health Service; IPW = inverse probability weighting; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-I = WIC-Medicaid Study I; WM-II = WIC-Medicaid II Feasibility Study.

Table F.MO.11. Estimates of the association between prenatal WIC participation and the primary outcome variables in Missouri: Comparing the model specifications in WIC-Medicaid I and II

Specification	Outcome measure						
	Low birth weight (%)	Gestational age (weeks)	Preterm birth (%)	Neonatal mortality (deaths per 1,000)	Overall infant mortality (deaths per 1,000)	Post-neonatal mortality (deaths per 1,000)	Medicaid costs for the infant (only) through 60 days ($)[a]
WM-II main findings							
WM-II methods (without multiple comparisons adjustment)	-0.26 (0.28)	-- [g]	-- [g]	0.64 (0.56)	1.47 (0.90)	0.83 (0.71)	-466 (211)*
Alternative specifications							
1. WM-I methods [b,c,d,e,f]	-2.10 (0.33)**	0.20 (0.03)**	-2.01 (0.34)**	-2.91 (0.82)**	-2.64 (1.02)**	0.18 (0.62)	-605 (232)**
2. WM-I methods, but control for gestational age [b,c,e,f]	-0.38 (0.25)	0.00 (0.00)	-- [g]	-0.52 (0.56)	0.13 (0.80)	0.65 (0.59)	-177 (187)
3. WM-II methods, but do not include gestational age in the propensity score model [d]	-1.83 (0.37)**	0.15 (0.03)**	-2.16 (0.39)**	-0.50 (0.70)	0.19 (1.00)	0.68 (0.71)	-940 (286)**
4. WM-II methods, but use regression adjustment (not IPW) [b]	-0.25 (0.24)	-- [g]	-- [g]	-0.04 (0.52)	0.93 (0.76)	0.94 (0.58)	-406 (176)*
5. WM-II methods, but use matching variables from WM-I [c]	-0.34 (0.27)	-- [g]	-- [g]	0.21 (0.61)	1.21 (0.85)	1.00 (0.61)	-172 (175)
6. WM-II methods, but include prenatal care adequacy as a matching variable [f]	-0.18 (0.29)	-- [g]	-- [g]	0.68 (0.57)	1.57 (0.92)	0.89 (0.73)	-580 (240)*
7. WM-II methods, but include multiple births in the sample [f]	-0.27 (0.31)	-- [g]	-- [g]	0.18 (0.57)	0.26 (1.10)	0.08 (0.95)	-378 (212)

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. Some observations were dropped, on a variable-by-variable basis, due to missing data. Refer to Appendix E, Table E.4 for sample sizes, by outcome, for the first row.

Outcomes are defined in Chapter III, Table III.3. Mortality measures are expressed in deaths per 1,000. Neonatal infant mortality includes infant deaths occurring fewer than 28 days after birth, overall infant mortality includes infant deaths in the first year, and postneonatal mortality includes infant deaths between 28 days and one year.

The first row of the table presents the difference in the outcomes between a group of WIC participants and a corresponding matched comparison group of nonparticipants, where the matched comparison group was constructed with inverse probability weighting, as described in the text. The propensity score model included gestational age and the full set of covariates shown in Chapter III, Table III.4. The remaining rows of the table present variations on the primary model using research methods more similar to the specifications from WM-I. The text on the previous page describes each specification/sample in more detail.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons. Note that, for comparability, the tests marked with daggers (†) are *not* adjusted for multiple comparisons in this table, although these tests *are* adjusted for multiple comparisons in Appendix E, Table E.4 and the figures in the report.

[a] The analysis of Medicaid costs includes only fee-for-service recipients. Approximately 64 percent of Medicaid recipients in Missouri are enrolled in Medicaid managed care. Managed care claims in Missouri do not include information about actual costs of services.

[b] In rows 1, 2, and 4, linear regression models (ordinary least squares) were used for Medicaid costs and gestational age, and logit models were used for the binary outcome variables. For binary outcomes, the table presents the mean marginal effect of any WIC participation among WIC participants, and standard errors were calculated with the delta method.

[c] Control variables (or matching variables) include the following: male newborn, mother's age (≤ 17**,** 18 or 19, 20–34, or ≥ 35 years), mother's race (Hispanic, non-Hispanic white, non-Hispanic black, non-Hispanic American/Indian Alaskan Native, non-Hispanic Asian Pacific Islander, or other/multiple races), married, number of previous live births and number of previous other birth outcomes (set to zero when number was unknown), mother's education (less than high school, high school grad or GED, some college or college graduate, or unknown), rural residence, and prenatal care from a public clinic. Underlines indicate the reference categories. Footnotes d, e, and f indicate whether gestational age, prenatal care adequacy, or a multiple birth dummy were also included as control variables (or matching variables). Note that not all of these controls were included in all five States in WM-I due to data limitations.

[d] In rows 1 and 3, gestational age is not included as a control variable (or matching variable).

[e] In rows 1, 2, and 6, prenatal care adequacy is included as a control variable (or matching variable). Specifically, indicators for intermediate, inadequate, or unknown prenatal care (Kessner index) are included as a control variables (or matching variables).

[f] In rows 1, 2, and 7, multiple births were included in the sample. For these rows, the unit of observation is the delivery in the last column and the unit of observation is the newborn in the remaining columns. A dummy variable for multiple births is includes as a control variable (or matching variable). For Medicaid costs, the "male" control variable equals one if at least one newborn was male and the WM-II control variables from the two to four records were combined.

[g] With IPW, the associations between WIC participation and preterm birth and gestational age methods is close to zero because measures of gestational age and preterm birth were included in the propensity score model. For this reason, IPW estimates are not shown. In the regression models, gestational age cannot be used as a dependent variable and independent variable at the same time.

g = grams; IPW = Inverse probability weighting; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-I = WIC-Medicaid I; WM-II = WIC-Medicaid II.

Table F.OK.11. Estimates of the association between prenatal WIC participation and the primary outcome variables in Oklahoma: Comparing the model specifications in WIC-Medicaid I and II

Specification	Outcome measure						
	Low birth weight (%)	Gestational age (weeks)	Preterm birth (%)	Neonatal mortality (deaths per 1,000)	Overall infant mortality (deaths per 1,000)	Post-neonatal mortality (deaths per 1,000)	Medicaid costs for the infant (only) through 60 days ($)[a]
WM-II main findings							
WM-II methods (without multiple comparisons adjustment)	-0.60	-- [g]	-- [g]	0.38	-0.30	-0.68	-29
	(0.32)			(0.69)	(1.13)	(0.90)	(108)
Alternative specifications							
1. WM-I methods [b,c,d,e,f]	-1.46	0.20	-1.69	-1.78	-2.87	-1.19	-266
	(0.36)**	(0.03)**	(0.40)**	(0.86)*	(1.20)*	(0.86)	(139)
2. WM-I methods, but control for gestational age [b,c,e,f]	0.01	-0.00	-- [g]	0.21	-0.53	-0.85	187
	(0.26)	(0.00)		(0.62)	(1.02)	(0.83)	(116)
3. WM-II methods, but do not include gestational age in the propensity score model [d]	-2.24	0.22	-2.84	-0.84	-1.71	-0.87	-347
	(0.42)**	(0.03)**	(0.48)**	(0.89)	(1.26)	(0.90)	(149)*
4. WM-II methods, but use regression adjustment (not IPW) [b]	-0.02	-- [g]	-- [g]	0.51	0.30	-0.20	-20
	(0.26)			(0.66)	(1.05)	(0.86)	(106)
5. WM-II methods, but use matching variables from WM-I [c]	-0.64	-- [g]	-- [g]	0.34	-0.46	-0.80	106
	(0.31)*			(0.68)	(1.12)	(0.89)	(99)
6. WM-II methods, but include prenatal care adequacy as a matching variable [f]	-0.56	-- [g]	-- [g]	0.53	-0.19	-0.72	80
	(0.33)			(0.68)	(1.10)	(0.87)	(105)
7. WM-II methods, but include multiple births in the sample [f]	-0.59	-- [g]	-- [g]	0.06	-1.02	-1.07	136
	(0.33)			(0.68)	(1.13)	(0.91)	(110)

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Oklahoma from February 2010 to January 2011 linked with a Vital Records birth certificate. Some observations were dropped, on a variable-by-variable basis, due to missing data. Refer to Appendix E, Table E.4 for sample sizes, by outcome, for the first row.

Outcomes are defined in Chapter III, Table III.3. Mortality measures are expressed in deaths per 1,000. Neonatal infant mortality includes infant deaths occurring fewer than 28 days after birth, overall infant mortality includes infant deaths in the first year, and postneonatal mortality includes infant deaths between 28 days and one year.

The first row of the table presents the difference in the outcomes between a group of WIC participants and a corresponding matched comparison group of nonparticipants, where the matched comparison group was constructed with inverse probability weighting, as described in the text. The propensity score model included gestational age and the full set of covariates shown in Chapter III, Table III.4. The remaining rows of the table present variations on the primary model using research methods more similar to the specifications from WM-I. The text on the previous page describes each specification/sample in more detail.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons. Note that, for comparability, the tests marked with daggers (†) are *not* adjusted for multiple comparisons in this table, although these tests *are* adjusted for multiple comparisons in Appendix E, Table E.4 and the figures in the report.

[a] The analysis of Medicaid costs excludes Native Americans. Oklahoma Medicaid did not provide cost data for Native Americans because many of these individuals receive care through the IHS, and IHS providers do not necessarily report all services and costs to Oklahoma Medicaid.

[b] In rows 1, 2, and 4, linear regression models (ordinary least squares) were used for Medicaid costs and gestational age, and logit models were used for the binary outcome variables. For binary outcomes, the table presents the mean marginal effect of any WIC participation among WIC participants, and standard errors were calculated with the delta method.

[c] Control variables (or matching variables) include the following: male newborn, mother's age (≤17**,** 18-19, 20-34, or ≥35 years), mother's race (Hispanic, non-Hispanic white, non-Hispanic black, non-Hispanic American/Indian Alaskan Native, non-Hispanic Asian Pacific Islander, or other/multiple races), married, number of previous live births and number of previous other birth outcomes (set to zero when number was unknown), mother's education (less than high school, high school grad or GED, some college or college graduate, or unknown), rural residence, and prenatal care from a public clinic. Underlines indicate the reference categories. Footnotes d, e, and f indicate whether gestational age, prenatal care adequacy, or a multiple birth dummy were also included as control variables (or matching variables). Note that not all of these controls were included in all five States in WM-I due to data limitations.

[d] In rows 1 and 3, gestational age is not included as a control variable (or matching variable).

[e] In rows 1, 2, and 6, gestational age is included as a control variable (or matching variable). Specifically, indicators for intermediate, inadequate, or unknown prenatal care (Kessner index) are included as a control variables (or matching variables).

[f] In rows 1, 2, and 7, multiple births were included in the sample. For these rows, the unit of observation is the delivery in the last column and the unit of observation is the newborn in the remaining columns. A dummy variable for multiple births is includes as a control variable (or matching variable). For Medicaid costs, the "male" control variable equals one if at least one newborn was male and the WM-II control variables from the two to four records were combined.

[g] With IPW, the associations between WIC participation and preterm birth and gestational age methods is close to zero because measures of gestational age and preterm birth were included in the propensity score model. For this reason, IPW estimates are not shown. In the regression models, gestational age cannot be used as a dependent variable and independent variable at the same time.

g = grams; IHS = Indian Health Service; IPW = Inverse probability weighting; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-I = WIC-Medicaid I; WM-II = WIC-Medicaid II.

Table F.12. Estimates of the association between any WIC participation and two primary outcome variables: Results from WM-I

	Florida	Minnesota	North Carolina	South Carolina	Texas
Medicaid costs for newborns and mothers from birth through 60 days postpartum ($)					
1. Specification that did not control for gestational age[a,b,c]					
Any prenatal WIC participation	-347	-277	-598	-565	-493
	(48)**	(154)	(73)**	(110)**	(74)**
2. Specification that controlled for gestational age [b,c]					
Any prenatal WIC participation	-154	122	-237	-247	-207
	(47)**	(156)	(71)**	(117)*	(73)**
WIC enrollment in first trimester	-147	10	-104	-38	-255
	(81)	(151)	(87)	(107)	(135)
Birthweight (grams)					
1. Specification that did not control for gestational age [c,d,e]					
Any prenatal WIC participation	73	51	117	113	77
	(7)**	(12)**	(10)**	(13)**	(8)**
2. Specification that controlled for gestational age [c,e]					
Any prenatal WIC participation	25	-5	32	47	26
	(6)**	(11)	(9)**	(13)**	(7)**
WIC enrollment in first trimester	73	35	63	29	71
	(11)**	(11)**	(11)**	(12)*	(14)**

Notes: This table reproduces selected results from the WM-I study. For the first specification in each panel, the table presents the regression-adjusted difference in outcomes between WIC participants and nonparticipants using a model that did *not* control for gestational age.

For the second specification in each panel, the table presents two regression coefficients—for any prenatal WIC participation and WIC enrollment in the first trimester—from a regression model that controlled for gestational age. The estimated association between WIC participation and the outcome is equal to the estimate on the first row for women who enrolled in the second or third trimesters, and the estimated association for women who enrolled in the first trimester is the sum of the two coefficients. Unfortunately, the WM-I reports do not report the fraction of WIC participants who enrolled in the first trimester, which is required to calculate the average association between all prenatal WIC participations and the two outcomes.

Standard errors are in parentheses. Asterisks indicate statistically regression coefficients at the $p < 0.01$ (**) and $p < 0.05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

[a] Source: Devaney et al. (1990), Table IV.1 and Appendix A.

[b] Source: Devaney et al. (1991), Table IV.6.

[c] Source: Devaney et al. (1992), Tables 3, 4, and 6.

[d] Source: Devaney et al. (1990), Table IV.4 and Appendix B.

[e] Source: Devaney et al. (1991), Table V.8.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-I = WIC-Medicaid Study I.

Table F.13. Estimates of the association between any prenatal WIC participation and the primary outcomes for observations with household incomes below selected cutoff levels

Outcome	Household income					
	Less than 30% FPL (1)	Less than 33% FPL (2)	Less than 50% FPL (3)	Less than 88% FPL (4)	Less than 100% FPL (5)	Full sample (6)
Medicaid costs for mother and infant, birth/delivery through 60 days postpartum ($)						
Missouri[a]	-314	-296	-261	-297	-259	-580*
	(217)	(215)	(212)	(199)	(197)	(226)
Oklahoma[b]	94	108	143	121	115	54
	(148)	(147)	(140)	(119)	(115)	(115)
Birthweight (in grams)						
Missouri	-3.16	-3.07	-2.73	-1.35	-0.87	1.02
	(6.11)	(6.07)	(5.96)	(5.70)	(5.70)	(5.95)
Oklahoma	11.29	9.28	11.85	4.25	4.27	9.98
	(8.45)	(8.38)	(7.80)	(6.85)	(6.70)	(6.49)
Sample size						
Missouri	27,736	27,937	29,082	32,275	32,528	37,837
Oklahoma	15,305	15,597	17,816	23,386	24,712	30,682

Source: database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid-covered births in Missouri from April 2010 to March 2011 linked with a Vital Records birth certificate. The last two rows indicate the potential number of mother–infant dyads that could be included in the analysis, though for both outcomes, observations were dropped on a variable-by-variable basis because of missing data and the restrictions mentioned in the footnotes below. Refer to Appendix E, Table E.4 for sample sizes, by outcome, for the full sample.

Chapter III, Table III.3 defines outcomes. The measure of Medicaid costs excludes costs for the mother from the prenatal period and physician costs associated with the birth or delivery (consistent with WM-I).

Each column presents the difference in the outcomes between WIC participants and a corresponding matched comparison group of nonparticipants. The matched comparison group was constructed with IPW, as described in the text. The propensity score model included gestational age and the full set of covariates shown in Chapter III, Table III.4 (with a few minor exceptions when small samples for certain subgroups did not permit the inclusion of rare characteristics). The first five columns exclude observations with household incomes above the specified cutoffs. Models were estimated separately for each subgroup.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < 0.01$ (**) and $p < 0.05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons. Note that, for comparability, the tests marked with daggers (†) are *not* adjusted for multiple comparisons in this table, although these tests *are* adjusted for multiple comparisons in Appendix E, Table E.4 and the figures in the report.

[a] The analysis of Medicaid costs includes only fee-for-service recipients. About 64 percent of Medicaid recipients in Missouri are enrolled in Medicaid Managed Care. Managed care claims in Missouri do not include information about actual costs of services.

[b] The analysis of Medicaid costs excludes Native Americans. Oklahoma Medicaid did not provide cost data for Native Americans, because many of them receive care through the IHS, and IHS providers do not necessarily report all services and costs to Oklahoma Medicaid.

FPL = Federal poverty level; IHS = Indian Health Service; IPW = inverse probability weighting; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

APPENDIX G

SUPPLEMENTARY TABLES FOR THE CHILDREN'S ANALYSIS

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Table G.MO.1. Participation in WIC in Missouri, by children's age in December 2010

	Cohort of 1-year-olds	Cohort of 2-year-olds	Cohort of 3-year-olds	Cohort of 4-year-olds
Percentage who participated in WIC at age:				
12–23 months	89.1	93.2	87.0	81.2
24–35 months		61.2	69.4	66.3
36–47 months			49.1	58.1
48–59 months				41.3
Average number of months on WIC at age:[a]				
12–23 months	4.6	7.8	7.8	7.6
24–35 months		4.7	7.7	7.6
36–47 months			4.7	7.8
48–59 months				4.6

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Missouri continuously enrolled from January to December 2010 linked with a Vital Records birth certificate.

[a] Average number of months children participated in WIC among children enrolled in WIC.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table G.OK.1. Participation in WIC in Oklahoma, by children's age in December 2010

	Cohort of 1-year-olds	Cohort of 2-year-olds	Cohort of 3-year-olds	Cohort of 4-year-olds
Percentage who participated in WIC at age				
12–23 months	64.8	72.3	66.9	62.5
24–35 months		49.7	57.6	53.6
36–47 months			42.6	50.0
48–59 months				36.2
Average number of months on WIC at age[a]				
12–23 months	4.6	7.5	7.6	7.0
24–35 months		4.6	7.5	7.5
36–47 months			4.6	7.5
48–59 months				4.6

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Oklahoma continuously enrolled from January to December 2010 linked with a Vital Records birth certificate.

[a] Average number of months children participated in WIC among children enrolled in WIC.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table G.2. Additional details on the construction of outcome variables from Medicaid claims

Construct or classification	Definition
Medicaid claims	Claims data included claims paid by Medicaid and encounter claims. In Missouri, void claims were removed from the file. In Oklahoma, the Medicaid agency provided final action claims.
Managed care claims	Missouri identified managed care claims based on the first two digits of the ICN number. In Oklahoma, there were no managed claims.
Calendar year 2010	The children's analysis included claims that occurred in calendar year 2010 (based on claim start/end dates).
Claim type	Using state-specific codes for the claim type field, claims were classified into the following six mutually exclusive categories: (1) inpatient claims, (2) physician and other medical or carrier claims (excluding dental claims), (3) outpatient claims, (4) prescription drug claims, (5) dental claims (included all claims identified as described below), and (6) other claims.
Type of provider	Physician; OB/GYN; midwife; PA, NP, and RN; birth center; and clinic; and public clinic claims were identified using provider type or billing provider specialty using state-specific codes.
Dental claims	Dental claims were identified using claim type, provider type, provider specialty (state-specific codes) or identified by a CPT/CDT procedure code beginning with "D" or ICD-9 diagnosis 520.x or 521.x or revenue code of 0512. For sensitivity analyses, the study team created subcategories of preventive dental services (CPT/CDT codes D1000–D1999) or dental treatment services (CPT/CDT codes D2000–D9999), as well as a measure based on CPT/CDT codes alone (without using claim type, provider type, or provider specialty codes).
Medicaid costs	Measures of the total cost paid by Medicaid—either for all claims or claims in a particular category (for example, inpatient claims)—were calculated as the costs recorded on the header row when a claim had a header row, or the sum of the costs recorded on individual claim lines when the claim did not have a header row. In Missouri, costs for managed care encounter claims were not included in the totals. Similar to the prenatal analysis, costs of claims were prorated in cases in which a claim did not start and end in 2010. For sensitivity analyses, an alternative measure was constructed that included the costs of all claims with a start date in calendar year 2010.
Hospitalizations	Hospital claims included inpatient claims plus other claims identified as hospital stays with provider type or billing provider specialty (state-specific codes). Measures of inpatient (hospital) utilization were constructed from a file with one row per discharge (cases with transfers between hospitals count as one discharge, regardless of the number of hospitals). For most discharges, the number of unique days in the hospital was equal to the discharge date minus the admission date plus one. Transfers were identified using state-specific patient discharge status codes. Measures for the number of days hospitalized were prorated similarly to measures of Medicaid costs (see above). In sensitivity analyses, these measures were calculated so that the number of days was not prorated (including all days for admissions with a start date in the relevant time period).
ER visits	Outpatient claims were flagged as emergency department visits if they had one of the following codes: Revenue center equal to 045X (that is 0450 to 0459) or 0981, or CPT/HCPCS procedural code = 99281 to 99285. (In Missouri, state-specific codes were also used to flag ER claims.) ER visits were excluded if they resulted in an inpatient hospitalization or an observation stay (beginning on the same day or the next day). Sensitivity analyses were conducted with relaxed criteria, including claims with the following CPT/HCPCS procedural codes: 99026 to 99027, 99175, 99288 to 99290, or G0380 to G0384.

Construct or classification	Definition
Physician claims	For the Medicaid cost measures, physician-only costs included the costs of medical or carrier claims with a physician provider type.
Diagnosis or treatment for otitis media	One or more claims with ICD-9 diagnosis code 382.xx
Diagnosis or treatment for upper respiratory infection	One or more claims with ICD-9 diagnosis codes 460.xx to 465.xx, and 786.2
Diagnosis or treatment for lower respiratory infection	One or more claims with ICD-9 diagnosis codes 466.xx and 480.xx-488.xx
Diagnosis or treatment for asthma	One or more claims with ICD-9 diagnosis codes 493.xx or NDC drug codes for inhaled corticosteroids. In sensitivity analyses, an alternative measure was constructed that also included ICD-9 diagnosis code 786.07.
Diagnosis or treatment for gastroenteritis	One or more claims with ICD-9 diagnosis codes 003.xx to 009.xx (except 003.1 and 003.2x), 787.0x, and 787.91
Diagnosis or treatment for iron deficiency anemia	One or more claims with ICD-9 diagnosis code 280.x
Diagnosis or treatment for allergy	One or more claims with ICD-9 diagnosis codes 477.x, 558.3, 558.4x, 691.x (except 691.0), 693.1, 708.x, 995.x (except 995.22, 995.23, 995.29, 995.4, 995.5, 995.8, and 995.9), V071, and V150.x
Immunizations	Immunization claims were identified according to the procedure in CMCS (2012, measure 6). In sensitivity analyses, the study team used a more comprehensive set of immunization codes, including any claims identified using the CMCS rule plus claims with CPT/HCPCS procedural codes from CDC's list of vaccination procedures (CDC 2013) or NDC drug codes from the CDC's list of vaccination drug codes (CDC 2013), or CPT/HCPCS procedural codes 90460-90461, 90465–9047, 90586, 90592, 90661, 90667, 90709, 90711, 90719, 90742, and 90749.
Well-child visits	Well-child visits were identified according to the procedure in CMCS (2012, measures 10 and 11). Claims were identified based on CPT/HCPCS procedural codes and ICD-9 diagnosis codes and the date of the claim in relation to the child's date of birth. The study team identified well-child visits for all children in the WM-II sample, not only those that met the denominator restrictions in CMCS (2013). In sensitivity analyses, we also constructed a measure for visits with a primary care practitioner based on CMS (2012, measure 14).
EPSDT visits	EPSDT visits were defined using state-specific coding rules.
EPSDT visits at ages 14–16 months	EPSDT visits for children observed during the 3 months when they were 14 to 16 months old (includes children born from October 2008 to September 2009)
EPSDT visits at ages 17–19 months	EPSDT visits for children observed during the 3 months when they were 17 to 19 months old (includes children born from July 2008 to June 2009)
EPSDT visits at ages 23–25 months	EPSDT visits for children observed during the 3 months when they were 23 to 25 months old (includes children born from January to December 2008
EPSDT visits at ages 2–4 years	EPSDT visits for children observed for 12 months after reaching age 2 (includes children born from January 2006 to January 2008)

Construct or classification	Definition
Age-specific EPSDT visits	In addition to a measure for having an EPSDT measure (anytime in 2010), the study team also constructed measures for EPSDT visits at particular ages when EPSDT visits are recommended: • EPSDT visits for children observed during the 3 months when they were 14 to 16 months old (includes children born from October 2008 to September 2009) • EPSDT visits for children observed during the 3 months when they were 17 to 19 months old (includes children born from July 2008 to June 2009) • EPSDT visits for children observed during the 3 months when they were 23 to 25 months old (includes children born from January to December 2008 • EPSDT visits for children observed for 12 months after reaching age 2 (includes children born from January 2006 to January 2008) In sensitivity analyses, the study team also constructed measures for • EPSDT visits at ages 14 to 16 months and 17 to 19 months • EPSDT visits at ages 17 to 19 months and 23 to 25 months • EPSDT visits at ages 14 to 16 months, 17 to 19 months, and 23 to 25 months • EPSDT visits at ages 14 to 16 months, 17 to 19 months, 23 to 25 months, or 2 to 4 years

CDC = Centers for Disease Control and Prevention; CDT = Code on Dental Procedures and Nomenclature; CHIP = Children's Health Insurance Program; CMCS = Center for Medicaid and CHIP Services; CPT = Current Procedural Terminology; EPSDT = Early Periodic Screening, Diagnosis, and Treatment; ER = emergency room; HCPCS = Healthcare Common Procedure Coding System ; ICD-9 = *International Classification of Diseases,* 9th edition; ICN = internal control number; NDC = National Drug Code; NP = nurse practitioner; OB/GYN = obstetrics and gynecology; PA = physician assistant; RN = registered nurse; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table G.MO.3. Difference in characteristics between WIC participants and nonparticipants in Missouri, by children's age in December 2010

	Children Aged 12-23m in Dec. 2010	Children Aged 24-35m in Dec. 2010		Children Aged 36-47m in Dec. 2010			Children Aged 48-59m in Dec. 2010			
	12–23 (1)	12–23 (2)	24–35 (3)	12–23 (4)	24–35 (5)	36–47 (6)	12–23 (7)	24–35 (8)	36–47 (9)	48–59 (10)
Mother's characteristics										
Age										
17 years or younger	3.4	0.5††	-0.8††	0.1††	-0.7††	-0.5††	-0.1††	-0.1††	-0.1	-0.5††
18 or 19 years	-1.9	-3.6	-1.6	-1.9	-0.9	-1.2	-1.2	-1.1	-0.7	-1.0
20–34 years	-3.0	1.4	0.9	-0.3	-0.0	-0.3	-0.8	-0.2	0.2	0.7
35 years or older	1.5	1.7	1.6	2.2	1.7	2.0	2.1	1.4	0.7	0.8
Race/ethnicity										
Hispanic	2.2††	4.0††	3.1††	2.8††	4.4††	4.7††	3.3††	3.0††	4.0††	4.0††
Non-Hispanic white	9.5	5.8	3.1	3.9	4.6	1.1	1.3	5.8	5.3	1.8
Non-Hispanic black	-12.3	-10.4	-6.3	-7.1	-9.0	-6.1	-4.2	-8.7	-9.0	-5.5
Non-Hispanic American Indian Alaskan Native	0.2	0.4	0.1	0.0	0.1	0.1	-0.1	0.1	0.0	-0.1
Non-Hispanic Asian Pacific Islander	1.3	0.1	-0.0	0.2	-0.1	0.0	-0.1	-0.2	-0.3	-0.2
Multiple races, other race, or unknown	-0.9	0.1	0.0	0.1	0.1	0.2	-0.1	0.0	0.1	0.1
Married	10.1**	3.1	8.0**	2.7*	7.3**	5.5**	0.6	7.0**	7.2**	5.3**
Education										
Less than high school	4.0	2.0	1.5††	0.0	2.5††	0.7††	0.8†	3.5††	1.7	1.1
High school grad or GED	-1.2	0.2	-1.8	0.7	-1.0	-0.6	2.1	-2.1	-1.2	-0.7
Some college, no degree	-3.2	-3.3	-0.8	0.0	-2.4	-1.3	-1.9	-2.2	-0.9	-0.7
College degree	1.0	0.5	1.2	-0.8	0.5	0.8	-0.9	0.5	0.3	0.3
Unknown	-0.6	0.5	-0.0	0.0	0.4	0.4	-0.2	0.3	0.1	0.0
Smoked during pregnancy	-1.5	1.7	-1.4*	-0.5	-1.9**	-3.5**	-0.6	-1.8*	-3.3**	-4.6**
Any previous live births	-7.9**	-6.0**	1.8*	-1.5	-0.1	-0.5	-1.9	0.3	-0.2	-1.4*
Short inter-pregnancy interval	-5.4*	-5.6**	2.7**	-5.4**	1.7*	1.2*	-5.1**	2.5**	2.1**	1.2*
Child's characteristics										
Gender is male	-5.6	-0.8	0.3	-0.0	-0.2	-0.3	0.9	0.2	-0.2	-0.6
Multiple birth	1.0	-0.9	0.7**	2.0**	0.1	0.4	1.3**	-0.3	-0.3	0.1

	Children Aged 12-23m in Dec. 2010	Children Aged 24-35m in Dec. 2010		Children Aged 36-47m in Dec. 2010			Children Aged 48-59m in Dec. 2010			
	12–23 (1)	12–23 (2)	24–35 (3)	12–23 (4)	24–35 (5)	36–47 (6)	12–23 (7)	24–35 (8)	36–47 (9)	48–59 (10)
Gestational age (in weeks)	0.2	0.1	-0.0	0.1	-0.1	-0.0	0.1**	-0.0	-0.0	-0.0
Preterm birth (< 37 weeks)	0.5	2.2*	0.4	0.9	-1.1*	-0.4	1.4*	-1.0*	-1.0*	-0.9*
Very preterm birth (<= 32 weeks)	1.1	1.0*	-0.3	0.4	-0.3	-0.2	0.8**	-0.1	-0.3	-0.1
Birth weight (in grams)	-3.7	4.1	-32.9**	8.5	-37.9**	-24.7**	29.0*	-33.4**	-32.1**	-30.9**
Low birth weight (< 2,500g)	1.0	1.5	-0.8	1.3	-0.9*	-0.7	2.3**	-0.7	-0.9*	-0.7
Very low birth weight (< 1,500g)	0.7	0.4	-0.1	0.6	-0.2	-0.1	0.7**	-0.0	-0.2	-0.2
Rural residence	12.6**	8.7**	9.3**	10.8**	8.2**	5.7**	7.4**	11.4**	10.0**	7.3**
Mean household income (as percentage of FPL	-5.5	-4.3*	-3.8**	-8.7**	-1.0	-3.4**	-5.2**	-0.2	0.3	-2.1**
Family income <= 100 percent of	-4.1*	-3.6**	-2.2**	-3.7**	-1.3*	-2.4**	-1.9*	1.2*	0.2	-1.7**
SNAP enrollment	-5.6**	-3.2**	-1.6**	-2.2**	-0.5	-1.2**	-0.8	0.1	0.4	-0.4
Medicaid managed care beneficiary	-9.6**	-8.9**	-6.6**	-4.1**	-5.3**	-4.4**	-3.7**	-6.9**	-6.6**	-4.4**
TANF enrollment	1.1	-4.4**	-1.2	-6.0**	2.0**	-0.2	-2.8**	-1.9**	0.8	-0.1
Aged, blind, and/or disabled Medicaid enrollment category	0.3	0.1	0.0	0.1	-0.0	0.1	0.1	0.1	0.2	0.1
Child Welfare Medicaid enrollment category	-1.2	0.4	0.5**	-1.3**	0.4*	0.5**	-0.5*	0.4	0.3	0.2
Sample size (number of WIC participants)	294	884	7,490	1,616	5,154	9,667	2,397	5,173	6,788	10,485

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Missouri continuously enrolled from January to December 2010 linked with a Vital Records birth certificate.

Each cell contains the difference in the characteristics between WIC participants and nonparticipants among children at a certain age (difference in proportions or means as indicated). For example, column (2) contains the difference in characteristics between children on WIC and not on WIC during the ages of 12-23 months, among children ages 24–35 months in 2010. Similarly, column (3) contains the difference in characteristics between children on WIC and not on WIC during the ages of 24–35 months, among children ages 24–35 months in 2010. The table presents these as percentage point differences for binary and categorical variables, and differences in means for continuous variables. Variables are defined in Table IV.4. Asterisks denote statistically significant differences between WIC participants and nonparticipants from Student's t-tests for dichotomous and continuous variables (*p < 0.05; ** p < 0.01), and daggers (†) denote statistically significant chi-squared tests for categorical variables († p < 0.05; †† p < 0.01).

See Appendix D for comparisons of WIC participants and nonparticipants after inverse probability weighting.

FPL = Federal poverty level; GED = general education development degree; SNAP = Supplemental Nutrition Assistance Program; TANF = Temporary Assistance for Needy Families; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table G.OK.3. Difference in characteristics between WIC participants and nonparticipants in Oklahoma, by children's age in December 2010

	Children Aged 12-23m in Dec. 2010	Children Aged 24-35m in Dec. 2010		Children Aged 36-47m in Dec. 2010			Children Aged 48-59m in Dec. 2010			
	12–23 (1)	12–23 (2)	24–35 (3)	12–23 (4)	24–35 (5)	36–47 (6)	12–23 (7)	24–35 (8)	36–47 (9)	48–59 (10)
Mother's characteristics										
Age										
17 years or younger	-0.2††	-0.2††	0.3††	0.2††	0.1	-0.9††	0.5††	0.0††	0.2††	-0.7††
18 or 19 years	-2.5	-1.7	-2.9	-0.0	-0.3	-1.4	-0.6	-0.4	-0.0	-0.3
20–34 years	0.7	-0.7	-0.2	-2.2	-1.0	0.4	-1.9	-1.5	-1.7	-0.7
35 years or older	2.0	2.6	2.8	1.9	1.1	1.8	1.9	1.9	1.6	1.8
Race/ethnicity										
Hispanic	16.2††	15.3††	15.9††	12.1††	17.1††	16.6††	12.8††	15.4††	18.0††	18.1††
Non-Hispanic white	-10.8	-7.9	-10.1	-6.7	-10.9	-11.5	-6.8	-8.2	-11.0	-10.8
Non-Hispanic black	-4.7	-6.0	-4.7	-4.2	-5.8	-4.7	-4.5	-5.8	-6.3	-6.3
Non-Hispanic American Indian Alaskan Native	-0.0	-1.5	-0.9	-1.1	-0.6	-0.5	-1.0	-0.7	-0.5	-0.7
Non-Hispanic Asian Pacific Islander	0.4	0.1	-0.1	-0.1	-0.0	0.1	-0.6	-0.5	-0.1	-0.1
Multiple races, other race, or unknown	-1.1	-0.1	-0.0	-0.0	0.1	-0.0	0.1	-0.2	-0.2	-0.3
Married	5.8**	6.2**	6.6**	3.3**	7.4**	6.2**	2.5*	6.2**	5.9**	5.8**
Education										
Less than high school	7.1††	5.7††	7.3††	6.6††	8.5††	6.9††	5.8††	7.2††	8.5††	7.6††
High school grad or GED	-0.3	-2.3	-4.6	-3.1	-5.5	-3.5	-0.7	-2.6	-5.2	-5.5
Some college, no degree	-6.4	-3.2	-2.9	-2.3	-3.7	-3.6	-3.2	-4.3	-3.9	-2.9
College degree	-0.5	-0.2	0.1	-1.1	0.6	0.2	-1.7	-0.4	0.5	0.8
Unknown	0.1	0.0	-0.0	0.0	0.1	0.0	-0.1	0.0	0.2	0.1
Smoked during pregnancy	-2.8**	-4.1**	-4.9**	-3.6**	-5.6**	-5.9**	-2.8**	-4.6**	-7.3**	-7.7**
Any previous live births	-2.1	-3.7**	0.4	-3.7**	-2.1*	0.1	-1.4	-0.2	-2.2*	-2.6**
Short inter-pregnancy interval	-3.1**	-5.8**	-0.7	-5.2**	-0.9	0.1	-2.0*	1.1	-0.1	-2.9**
Child's characteristics										
Gender is male	0.6	-1.6	-1.0	0.3	0.7	1.1	-0.7	-1.3	-1.3	-0.4
Multiple birth	0.3	0.2	-0.4	1.3**	-0.2	-0.3	1.3**	0.8*	-0.1	0.0

	Children Aged 12-23m in Dec. 2010	Children Aged 24-35m in Dec. 2010		Children Aged 36-47m in Dec. 2010			Children Aged 48-59m in Dec. 2010			
	12–23 (1)	12–23 (2)	24–35 (3)	12–23 (4)	24–35 (5)	36–47 (6)	12–23 (7)	24–35 (8)	36–47 (9)	48–59 (10)
Gestational age (in weeks)	-0.1*	-0.1	-0.1**	0.1*	-0.1	-0.1**	0.1	-0.0	-0.1**	-0.1**
Preterm birth (< 37 weeks)	-1.3	-1.1	-1.0	1.2	-0.7	-0.8	1.1	-0.7	-1.2*	-1.4**
Very preterm birth (<= 32 weeks)	0.2	0.2	-0.5	0.9**	0.0	-0.3	0.7*	0.2	0.3	-0.0
Birth weight (in grams)	-23.4	-30.3*	-31.4**	4.7	-44.2**	-40.7**	1.0	-27.9**	-49.2**	-57.7**
Low birth weight (< 2,500g)	-0.2	-0.9	-1.0*	1.2*	-1.4*	-1.2*	1.1	-0.6	-1.1*	-1.0*
Very low birth weight (< 1,500g)	0.5	0.2	-0.3	0.7**	0.2	-0.2	0.5*	0.3	0.1	-0.0
Rural residence	-1.2	-0.3	0.3	0.1	1.3	-1.9*	-0.5	-0.1	0.1	-0.4
Mean household income (as percentage of FPL	-8.5**	-7.5**	-6.8**	-3.9**	-3.3**	-4.9**	-4.6**	-5.3**	-4.7**	-6.9**
Family income <= 100 percent of FPL	-4.9**	-5.0**	-4.6**	-0.6	-1.9*	-3.4**	-1.0	-1.4	-2.0**	-3.7**
TANF enrollment	0.0	0.1	0.1	-0.5	-0.3	-0.1	-0.4	-0.2	0.4	0.3
Aged, blind, and/or disabled Medicaid enrollment category	0.1	-0.1	-0.1	0.2	0.0	-0.1	0.1	-0.0	-0.2	-0.2
Child Welfare Medicaid enrollment category	0.1	0.5	0.6*	-0.7	0.4	0.4	0.2	0.8*	0.8*	0.6
Sample size (number of WIC participants)	1,541	2,528	5,694	2,857	3,952	6,210	3,250	4,154	4,567	6,733

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Oklahoma continuously enrolled from January to December 2010 linked with a Vital Records birth certificate.

Each cell contains the difference in the characteristics between WIC participants and nonparticipants among children at a certain age (difference in proportions or means as indicated). For example, column (2) contains the difference in characteristics between children on WIC and not on WIC during the ages of 12–23 months, among children ages 24–35 months in 2010. Similarly, column (3) contains the difference in characteristics between children on WIC and not on WIC during the ages of 24–35 months, among children ages 24–35 months in 2010. The table presents these as percentage point differences for binary and categorical variables, and differences in means for continuous variables. Variables are defined in Table IV.4. Asterisks denote statistically significant differences between WIC participants and nonparticipants from Student's t-tests for dichotomous and continuous variables (*p < 0.05; ** p < 0.01), and daggers (†) denote statistically significant chi-squared tests for categorical variables ($^{\dagger}p$ < 0.05; †† p < 0.01).

See Appendix D for comparisons of WIC participants and nonparticipants after inverse probability weighting.

FPL = Federal poverty level; GED = general education development degree; TANF = Temporary Assistance for Needy Families; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WM-II = WIC-Medicaid II Feasibility Study.

Table G.MO.4. Child and household characteristics associated with child WIC participation: Estimates from the propensity score models, by age cohort

	Cohort of 1-year-olds	Cohort of 2-year-olds	Cohort of 3-year-olds	Cohort of 4-year-olds
Age: 17 years or younger	-0.003 (0.013)	-0.005 (0.013)	0.014 (0.013)	0.001 (0.013)
Age: 18 or 19 years	-0.037 (0.009)**	-0.011 (0.008)	0.004 (0.008)	0.016 (0.009)
Age: 35 years or older	0.077 (0.010)**	0.052 (0.010)**	0.029 (0.010)**	0.021 (0.011)
Race/ethnicity: Hispanic	0.128 (0.009)**	0.106 (0.008)**	0.107 (0.008)**	0.107 (0.008)**
Race/ethnicity: Non-Hispanic black	-0.003 (0.007)	-0.011 (0.007)	-0.019 (0.007)**	-0.027 (0.007)**
Race/ethnicity: Non-Hispanic American Indian/Alaskan Native	0.057 (0.032)	0.066 (0.030)*	0.062 (0.030)*	0.075 (0.032)*
Race/ethnicity: Non-Hispanic Asian/Pacific Islander	0.018 (0.021)	-0.001 (0.021)	-0.031 (0.022)	0.020 (0.023)
Race/ethnicity: Non-Hispanic other race or multi-race or unknown	-0.056 (0.038)	-0.044 (0.044)	-0.033 (0.042)	0.041 (0.035)
Married: Yes	0.028 (0.006)**	0.011 (0.006)	-0.004 (0.006)	-0.005 (0.006)
Education: Less than high school	0.011 (0.006)	0.008 (0.006)	0.011 (0.006)	0.017 (0.006)**
Education: Some college, no degree	-0.041 (0.007)**	-0.029 (0.007)**	-0.024 (0.007)**	-0.025 (0.007)**
Education: College degree	-0.083 (0.013)**	-0.059 (0.013)**	-0.067 (0.014)**	-0.049 (0.015)**
Education: Unknown	0.013 (0.021)	0.005 (0.021)	0.038 (0.019)*	0.053 (0.020)**
Rural residence	0.097 (0.006)**	0.099 (0.005)**	0.098 (0.005)**	0.090 (0.006)**
Family income: $0	0.014 (0.010)	0.025 (0.009)**	0.008 (0.009)	-0.017 (0.009)
Family income: > 100% FPL	0.095 (0.022)**	0.070 (0.017)**	0.022 (0.028)	0.003 (0.030)
Family income: unknown	0.240 (0.052)**	0.211 (0.033)**	0.076 (0.104)	-0.061 (0.163)
Family income (% FPL)[a]	0.0003 (0.0001)	0.0002 (0.0001)	0.0001 (0.0001)	-0. 00005 (0.0001)
SNAP enrollment	0.090 (0.009)**	0.097 (0.010)**	0.074 (0.010)**	0.100 (0.010)**
TANF enrollment	0.038 (0.006)**	0.038 (0.006)**	0.034 (0.006)**	0.042 (0.007)**
Aged, blind, and/or disabled Medicaid enrollment	0.054 (0.041)	-0.014 (0.037)	-0.019 (0.033)	0.040 (0.032)
Child welfare Medicaid enrollment	0.159 (0.017)**	0.153 (0.016)**	0.137 (0.014)**	0.100 (0.020)**
Medicaid managed care beneficiary	-0.028 (0.006)**	-0.043 (0.006)**	-0.030 (0.006)**	-0.030 (0.006)**
Cigarette consumption during pregnancy: Yes	-0.010 (0.006)	-0.009 (0.006)	-0.004 (0.006)	-0.004 (0.006)
Cigarette consumption during pregnancy: Unknown	-0.055 (0.050)	-0.041 (0.036)	-0.034 (0.039)	-0.143 (0.054)
Any prior live birth: Yes	-0.112 (0.006)**	-0.087 (0.006)**	-0.070 (0.006)**	-0.087 (0.006)**
Any prior live birth: Unknown	-0.024 (0.048)	-0.077 (0.045)	-0.026 (0.036)	-0.058 (0.029)*

	Cohort of 1-year-olds	Cohort of 2-year-olds	Cohort of 3-year-olds	Cohort of 4-year-olds
Inter-pregnancy interval: Short or very short	-0.025 (0.006)**	-0.016 (0.006)**	-0.017 (0.006)**	-0.007 (0.006)
Short inter-pregnancy interval: Unknown	-0.013 (0.010)	0.013 (0.009)	-0.013 (0.010)	-0.003 (0.010)
Gender is male	0.002 (0.005)	0.003 (0.005)	0.006 (0.005)	-0.003 (0.005)
Multiple birth	-0.138 (0.018)**	-0.133 (0.019)**	-0.013 (0.016)	-0.015 (0.016)
Gestational age (in weeks)	0.004 (0.002)	0.002 (0.002)	-0.003 (0.002)	0.002 (0.002)
Gestational age: 37 or 38 weeks	0.008 (0.008)	0.005 (0.008)	-0.014 (0.008)	-0.001 (0.008)
Gestational age: 33–36 weeks	0.002 (0.015)	0.020 (0.014)	-0.027 (0.015)	0.001 (0.015)
Gestational age: 33 weeks or fewer	0.026 (0.035)	0.054 (0.030)	-0.048 (0.038)	0.001 (0.034)
Birthweight	-0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Birthweight: 1,500g to 2,499g	-0.097 (0.025)**	-0.074 (0.022)**	-0.078 (0.024)**	-0.016 (0.028)
Birthweight: 2,500g to 3,999g	-0.103 (0.027)**	-0.100 (0.023)**	-0.081 (0.025)**	-0.027 (0.030)
Birthweight: 4,000g or more	-0.089 (0.032)**	-0.097 (0.028)**	-0.071 (0.029)*	-0.016 (0.035)
Quarter of birth: 2008q4	-0.024 (0.007)**	--	--	--
Quarter of birth: 2009q1	-0.054 (0.007)**	--	--	--
Quarter of birth: 2009q2	-0.058 (0.007)**	--	--	--
Quarter of birth: 2007q4	--	-0.014 (0.007)*	--	--
Quarter of birth: 2008q1	--	-0.025 (0.007)**	--	--
Quarter of birth: 2008q2	--	-0.034 (0.007)**	--	--
Quarter of birth: 2006q4	--	--	-0.007 (0.007)	--
Quarter of birth: 2007q1	--	--	0.001 (0.007)	--
Quarter of birth: 2007q2	--	--	-0.006 (0.007)	--
Quarter of birth: 2005q4	--	--	--	0.006 (0.007)
Quarter of birth: 2006q1	--	--	--	0.000 (0.007)
Quarter of birth: 2006q2	--	--	--	0.016 (0.007)*
Sample size	29,891	28,465	27,032	24,810

Notes: This table presents the marginal effects implied by the four propensity score models (one model for each age cohort). The propensity score model presented in this table included all children in each cohort's analysis sample (including managed care beneficiaries in Missouri). Marginal effects are the change in the predicted probability of participating in WIC given a one-unit change in the matching variable, holding all other variables constant. Marginal effects were calculated for each observation, and then the mean marginal effect was calculated by averaging across all observations. Robust standard errors (in parentheses) were calculated using the delta method. Asterisks indicate statistically significant mean marginal effects at the $p < .01$ (**) and $p < .05$ (*) levels.

[a] Marginal effects are not presented for interaction terms included in the propensity score model. The model included household income categories interacted with household income.

SNAP = Supplemental Nutrition Assistance Program; TANF = Temporary Assistance for Needy Families

Table G.OK.4. Child and household characteristics associated with child WIC participation: Estimates from the propensity score models, by age cohort

	Cohort of 1-year-olds	Cohort of 2-year-olds	Cohort of 3-year-olds	Cohort of 4-year-olds
Age: 17 years or younger	-0.044 (0.017)*	0.001 (0.017)	0.015 (0.017)	0.011 (0.017)
Age: 18 or 19 years	-0.041 (0.011)**	0.014 (0.011)	0.012 (0.011)	0.005 (0.012)
Age: 35 years or older	0.060 (0.016)**	0.011 (0.015)	0.014 (0.015)	0.010 (0.015)
Race/ethnicity: Hispanic	0.176 (0.011)**	0.181 (0.011)**	0.151 (0.011)**	0.179 (0.012)**
Race/ethnicity: Non-Hispanic black	0.027 (0.010)*	0.025 (0.010)*	0.024 (0.010)*	0.018 (0.010)
Race/ethnicity: Non-Hispanic American Indian/Alaskan Native	-0.136 (0.018)**	-0.141 (0.016)**	-0.111 (0.016)**	-0.101 (0.017)**
Race/ethnicity: Non-Hispanic Asian/Pacific Islander	0.014 (0.026)	0.013 (0.025)	0.008 (0.027)	-0.007 (0.027)
Race/ethnicity: Non-Hispanic other race or multi-race or unknown	-0.118 (0.035)**	-0.041 (0.063)	-0.019 (0.047)	0.033 (0.047)
Married: Yes	0.009 (0.008)	0.006 (0.007)	-0.006 (0.007)	0.004 (0.008)
Education: Less than high school	0.036 (0.009)**	0.032 (0.009)**	0.028 (0.009)**	0.009 (0.009)
Education: Some college, no degree	-0.046 (0.009)**	-0.001 (0.009)	-0.026 (0.009)**	-0.039 (0.009)**
Education: College degree	-0.064 (0.016)**	-0.052 (0.015)**	-0.036 (0.015)*	-0.064 (0.016)**
Education: Unknown	-0.004 (0.050)	0.051 (0.047)	0.012 (0.042)	-0.065 (0.044)
Rural residence	-0.034 (0.007)**	-0.022 (0.007)**	-0.025 (0.007)**	-0.008 (0.007)
Rural residence: unknown	-0.059 (0.067)	-0.050 (0.062)	-0.090 (0.058)	-0.269 (0.069)**
Family income: $0	0.010 (0.012)	0.029 (0.011)*	0.028 (0.012)*	-0.011 (0.011)
Family income: >100% FPL	0.072 (0.030)*	0.059 (0.027)*	0.047 (0.026)	0.004 (0.026)
Family income (% FPL)[a]	0.0003 (0.0002)	0.0002 (0.0001)	0.0003 (0.0001)*	0.00005 (0.0001)
TANF enrollment	0.031 (0.037)	0.023 (0.030)	0.060 (0.025)*	0.024 (0.025)
Aged, blind, and/or disabled Medicaid enrollment	-0.066 (0.048)	0.010 (0.047)	0.024 (0.046)	0.027 (0.042)
Child welfare Medicaid enrollment	0.006 (0.019)	0.007 (0.018)	0.012 (0.018)	0.047 (0.020)*
Cigarette consumption during pregnancy: Yes	0.009 (0.009)	0.017 (0.008)*	0.005 (0.008)	-0.001 (0.009)
Cigarette consumption during pregnancy: Unknown	-0.001 (0.024)	-0.005 (0.067)	-0.065 (0.077)	-0.032 (0.117)
Any prior live birth: Yes	-0.054 (0.009)**	-0.059 (0.009)**	-0.051 (0.009)**	-0.052 (0.009)**
Inter-pregnancy interval: Short or very short	-0.020 (0.009)*	-0.005 (0.009)	-0.008 (0.009)	-0.010 (0.009)
Short inter-pregnancy interval: Unknown	-0.019 (0.024)	0.040 (0.026)	0.027 (0.021)	-0.008 (0.021)
Gender is male	0.002 (0.007)	-0.004 (0.007)	0.002 (0.007)	-0.002 (0.007)

	Cohort of 1-year-olds	Cohort of 2-year-olds	Cohort of 3-year-olds	Cohort of 4-year-olds
Multiple birth	0.038 (0.024)	0.011 (0.024)	0.053 (0.024)*	0.009 (0.024)
Gestational age (in weeks)	0.003 (0.005)	0.011 (0.005)*	0.000 (0.005)	0.003 (0.005)
Gestational age: 37 or 38 weeks	-0.008 (0.011)	0.012 (0.012)	-0.004 (0.011)	-0.004 (0.012)
Gestational age: 33–36 weeks	-0.008 (0.024)	0.033 (0.024)	0.002 (0.024)	0.014 (0.025)
Gestational age: 33 weeks or fewer	0.018 (0.062)	0.079 (0.061)	0.045 (0.063)	0.025 (0.062)
Gestational age: Unknown	3.252 (5.105)	10.985 (5.093)*	0.399 (4.814)	3.289 (5.032)
Birthweight	-0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Birthweight: 1,500g to 2,499g	-0.056 (0.048)	-0.101 (0.049)*	0.008 (0.052)	-0.022 (0.047)
Birthweight: 2,500g to 3,999g	-0.068 (0.051)	-0.099 (0.052)	0.010 (0.055)	-0.033 (0.050)
Birthweight: 4,000g or more	-0.059 (0.056)	-0.101 (0.057)	0.039 (0.060)	-0.040 (0.055)
Quarter of birth: 2008q4	-0.039 (0.010)**	--	--	--
Quarter of birth: 2009q1	-0.056 (0.010)**	--	--	--
Quarter of birth: 2009q2	-0.074 (0.010)**	--	--	--
Quarter of birth: 2007q4	--	0.013 (0.009)	--	--
Quarter of birth: 2008q1	--	-0.012 (0.009)	--	--
Quarter of birth: 2008q2	--	-0.007 (0.009)	--	--
Quarter of birth: 2006q4	--	--	-0.017 (0.009)	--
Quarter of birth: 2007q1	--	--	-0.024 (0.009)*	--
Quarter of birth: 2007q2	--	--	-0.019 (0.009)*	--
Quarter of birth: 2005q4	--	--	--	-0.018 (0.010)
Quarter of birth: 2006q1	--	--	--	-0.008 (0.010)
Quarter of birth: 2006q2	--	--	--	0.004 (0.010)
Sample size	17,291	15,974	15,780	14,252

Notes: This table presents the marginal effects implied by the four propensity score models (one model for each age cohort). The propensity score model presented in this table included all children in each cohort's analysis sample, including managed care beneficiaries in Missouri. Marginal effects are the change in the predicted probability of participating in WIC given a one-unit change in the matching variable, holding all other variables constant. Marginal effects were calculated for each observation, and then the mean marginal effect was calculated by averaging across all observations. Robust standard errors (in parentheses) were calculated using the delta method. Asterisks indicate statistically significant mean marginal effects at the $p < .01$ (**) and $p < .05$ (*) levels.

[a] Marginal effects are not presented for interaction terms included in the propensity score model. The model included household income categories interacted with household income.

FPL = Federal poverty level; TANF = Temporary Assistance for Needy Families.

Table G.MO.5. Estimates of the association between any child WIC participation and the primary outcomes in Missouri, by age cohort

Outcome	Age cohort	WIC participants (1)	Matched comparison group (2)	Difference (3)	Standard error (4)	Effect size (5)	Sample size (6)
Health care utilization							
Any well-child visits	1-year-olds	72.62	57.47	15.14**	0.65	0.318	29,891
	2-year-olds	71.33	54.47	16.86**	0.76	0.349	28,465
	3-year-olds	70.90	54.37	16.53**	0.82	0.342	27,032
	4-year-olds	70.66	55.80	14.85**	0.83	0.308	24,810
Any emergency room visits	1-year-olds	48.16	43.97	4.19**	0.67	0.084	29,891
	2-year-olds	41.36	37.79	3.57**	0.74	0.073	28,465
	3-year-olds	35.34	33.12	2.22*	0.78	0.047	27,032
	4-year-olds	31.42	27.55	3.87**	0.75	0.085	24,810
Diagnosis and treatment of common childhood illnesses							
Any visit for the diagnosis and treatment of a common childhood illness (%)[a]	1-year-olds	85.13	78.57	6.56**	0.55	0.170	29,891
	2-year-olds	76.73	68.30	8.43**	0.70	0.189	28,465
	3-year-olds	70.58	63.79	6.79**	0.77	0.145	27,032
	4-year-olds	67.55	59.29	8.25**	0.82	0.171	24,810
Medicaid costs							
Total Medicaid costs ($)[b]	1-year-olds	2,495	2,277	219	373	0.016	9,292
	2-year-olds	1,967	1,331	637**	160	0.085	9,004
	3-year-olds	1,784	2,001	-217	342	-0.021	8,599
	4-year-olds	2,159	1,556	603*	286	0.054	8,029

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Missouri continuously enrolled from January to December 2010 linked with a Vital Records birth certificate. Outcomes are defined in Table IV.3.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in Chapter III. The propensity score model included the full set of covariates shown in Table IV.4.

Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance account for multiple comparisons in the health care utilization domain using methods from Hothorn et al. (2008, 2013).

[a] Otitis media (ear infection), upper respiratory infection, lower respiratory infection, asthma, iron deficiency anemia, gastroenteritis, or allergies.

[b] The analysis of Medicaid costs includes only fee-for-service recipients. Approximately 68 percent of Medicaid recipients in Missouri are enrolled in Medicaid managed care. Managed care claims in Missouri do not include information about actual costs of services.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WM-II = WIC-Medicaid II Feasibility Study.

Table G.OK.5. Estimates of the association between any child WIC participation in Oklahoma and the primary outcomes, by age cohort

Outcome	Age cohort	WIC participants (1)	Matched comparison group (2)	Difference (3)	Standard error (4)	Effect size (5)	Sample size (6)
Health care utilization							
Any well-child visits	1-year-olds	70.68	61.70	8.99**	0.84	0.190	17,291
	2-year-olds	67.18	59.83	7.35**	0.99	0.153	15,974
	3-year-olds	68.38	62.57	5.81**	0.97	0.122	15,780
	4-year-olds	74.02	70.16	3.86**	0.99	0.086	14,252
Any emergency room visits	1-year-olds	58.54	55.59	2.95**	0.90	0.060	17,291
	2-year-olds	50.90	46.90	4.00**	1.01	0.080	15,974
	3-year-olds	43.55	40.53	3.02**	1.01	0.061	15,780
	4-year-olds	40.23	36.35	3.88**	1.08	0.080	14,252
Diagnosis and treatment of common childhood illnesses							
Any visit for the diagnosis and treatment of a common childhood illness (%)[a]	1-year-olds	86.17	83.40	2.77**	0.67	0.077	17,291
	2-year-olds	77.47	72.50	4.97**	0.90	0.115	15,974
	3-year-olds	71.52	67.46	4.06**	0.96	0.088	15,780
	4-year-olds	68.39	64.79	3.60**	1.05	0.076	14,252
Medicaid costs							
Total Medicaid costs ($)	1-year-olds	2,165	2,198	-33	130	-0.004	17,291
	2-year-olds	1,746	2,293	-547*	277	-0.049	15,974
	3-year-olds	1,725	1,921	-196	152	-0.030	15,780
	4-year-olds	2,017	2,581	-563	3171	-0.051	14,252

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Oklahoma continuously enrolled from January to December 2010 linked with a Vital Records birth certificate. Outcomes are defined in Table IV.3.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in Chapter III. The propensity score model included the full set of covariates shown in Table IV.4.

Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance account for multiple comparisons in the health care utilization domain using methods from Hothorn et al. (2008, 2013).

[a] Otitis media (ear infection), upper respiratory infection, lower respiratory infection, asthma, iron deficiency anemia, gastroenteritis, or allergies.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WM-II = WIC-Medicaid II Feasibility Study.

Table G.MO.6. Estimates of the association between any child WIC participation and the secondary health care utilization measures in Missouri, by age cohort

Outcome	Age cohort	WIC participants (1)	Matched comparison group (2)	Difference (3)	Standard error (4)	Effect size (5)	Sample size (6)
Any visits with an immunization (CHIPRA code list)	1-year-olds	71.37	64.99	6.39**	0.65	0.137	29,891
	2-year-olds	44.51	42.04	2.47**	0.76	0.050	28,465
	3-year-olds	35.40	32.26	3.14**	0.78	0.066	27,032
	4-year-olds	41.38	38.66	2.72**	0.82	0.055	24,810
EPSDT visit	1-year-olds	93.91	84.53	9.39**	0.47	0.303	29,891
	2-year-olds	85.09	72.51	12.57**	0.67	0.308	28,465
	3-year-olds	81.35	68.54	12.81**	0.74	0.296	27,032
	4-year-olds	80.64	67.96	12.67**	0.77	0.290	24,810
Any hospitalizations	1-year-olds	5.27	4.85	0.43	0.31	0.019	29,891
	2-year-olds	3.63	2.78	0.85**	0.27	0.048	28,465
	3-year-olds	2.43	2.39	0.04	0.24	0.003	27,032
	4-year-olds	2.37	1.77	0.60**	0.23	0.042	24,810
Any dental care visits (comprehensive code list)	1-year-olds	7.95	5.46	2.49**	0.33	0.099	29,891
	2-year-olds	3.20	2.40	0.80**	0.27	0.049	28,465
	3-year-olds	3.84	3.28	0.56	0.33	0.030	27,032
	4-year-olds	4.81	4.24	0.57	0.39	0.028	24,810
Number of visits with an immunization (CHIPRA code list)	1-year-olds	1.49	1.27	0.22**	0.02	0.179	29,891
	2-year-olds	0.56	0.51	0.05**	0.01	0.071	28,465
	3-year-olds	0.40	0.37	0.03**	0.01	0.046	27,032
	4-year-olds	0.46	0.43	0.02*	0.01	0.041	24,810
Number of well-child visits	1-year-olds	1.13	0.78	0.35**	0.01	0.380	29,891
	2-year-olds	1.06	0.65	0.41**	0.01	0.487	28,465
	3-year-olds	1.07	0.65	0.42**	0.01	0.477	27,032
	4-year-olds	1.03	0.65	0.37**	0.01	0.443	24,810
Number of hospitalizations	1-year-olds	0.07	0.07	0.00	0.01	0.011	29,891
	2-year-olds	0.05	0.03	0.01**	0.00	0.044	28,465
	3-year-olds	0.03	0.03	-0.00	0.00	-0.009	27,032
	4-year-olds	0.03	0.02	0.01	0.00	0.031	24,810
Days hospitalized	1-year-olds	0.29	0.32	-0.03	0.08	-0.006	29,891
	2-year-olds	0.17	0.14	0.03	0.03	0.016	28,465
	3-year-olds	0.10	0.14	-0.04	0.03	-0.024	27,032
	4-year-olds	0.12	0.13	-0.02	0.06	-0.005	24,810
Number of emergency room visits	1-year-olds	1.02	0.92	0.11**	0.02	0.071	29,891
	2-year-olds	0.77	0.66	0.11**	0.02	0.095	28,465
	3-year-olds	0.59	0.54	0.06**	0.02	0.058	27,032
	4-year-olds	0.51	0.42	0.09**	0.01	0.102	24,810

Outcome	Age cohort	WIC participants (1)	Matched comparison group (2)	Difference (3)	Standard error (4)	Effect size (5)	Sample size (6)
Number of dental care visits (comprehensive code list)	1-year-olds	0.10	0.07	0.03**	0.00	0.075	29,891
	2-year-olds	0.04	0.03	0.01**	0.00	0.045	28,465
	3-year-olds	0.05	0.04	0.01*	0.00	0.034	27,032
	4-year-olds	0.07	0.06	0.01	0.01	0.018	24,810
	1-year-olds	0.10	0.07	0.03**	0.00	0.075	29,891

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Missouri continuously enrolled from January to December 2010 linked with a Vital Records birth certificate. Outcomes are defined in Table IV.3.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in Chapter III. The propensity score model included the full set of covariates shown in Table IV.4.

Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did not account for multiple comparisons.

CHIPRA = Children's Health Insurance Program Reauthorization Act; EPSDT = Early Periodic Screening, Diagnosis, and Treatment; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table G.OK.6. Estimates of the association between any child WIC participation and the secondary health care utilization measures in Oklahoma, by age cohort

Outcome	Age cohort	WIC participants (1)	Matched comparison group (2)	Difference (3)	Standard error (4)	Effect size (5)	Sample size (6)
Any visits with an immunization (CHIPRA code list)	1-year-olds	55.27	50.16	5.11**	0.90	0.102	17,291
	2-year-olds	27.58	26.41	1.17	0.89	0.026	15,974
	3-year-olds	21.49	20.41	1.08	0.84	0.027	15,780
	4-year-olds	29.47	27.39	2.09*	1.00	0.046	14,252
EPSDT visit	1-year-olds	81.64	75.08	6.56**	0.76	0.159	17,291
	2-year-olds	60.33	55.44	4.90**	1.00	0.099	15,974
	3-year-olds	58.51	54.21	4.30**	1.02	0.087	15,780
	4-year-olds	58.24	55.91	2.33*	1.09	0.047	14,252
Any hospitalizations	1-year-olds	5.34	5.32	0.02	0.39	0.001	17,291
	2-year-olds	3.45	4.46	-1.02*	0.42	-0.052	15,974
	3-year-olds	2.66	2.67	-0.01	0.33	-0.001	15,780
	4-year-olds	2.44	2.53	-0.09	0.33	-0.006	14,252
Any dental care visits (comprehensive code list)	1-year-olds	7.16	6.51	0.65	0.45	0.026	17,291
	2-year-olds	5.67	4.91	0.76	0.44	0.034	15,974
	3-year-olds	7.20	5.77	1.43**	0.49	0.058	15,780
	4-year-olds	7.09	7.09	-0.00	0.60	-0.000	14,252
Number of visits with an immunization (CHIPRA code list)	1-year-olds	1.06	0.92	0.14**	0.02	0.117	17,291
	2-year-olds	0.35	0.32	0.03*	0.01	0.048	15,974
	3-year-olds	0.25	0.23	0.02*	0.01	0.043	15,780
	4-year-olds	0.33	0.30	0.03*	0.01	0.052	14,252
Number of well-child visits	1-year-olds	1.00	0.86	0.14**	0.01	0.165	17,291
	2-year-olds	0.88	0.74	0.14**	0.02	0.180	15,974
	3-year-olds	0.96	0.85	0.12**	0.02	0.126	15,780
	4-year-olds	1.03	0.95	0.09**	0.02	0.097	14,252
Number of hospitalizations	1-year-olds	0.08	0.10	-0.02	0.01	-0.021	17,291
	2-year-olds	0.05	0.12	-0.07*	0.03	-0.055	15,974
	3-year-olds	0.03	0.06	-0.02	0.02	-0.035	15,780
	4-year-olds	0.04	0.15	-0.11*	0.05	-0.065	14,252
Days hospitalized	1-year-olds	0.38	0.58	-0.21	0.12	-0.027	17,291
	2-year-olds	0.26	0.77	-0.51	0.27	-0.049	15,974
	3-year-olds	0.15	0.38	-0.23	0.13	-0.039	15,780
	4-year-olds	0.25	1.21	-0.96*	0.41	-0.068	14,252

Outcome	Age cohort	WIC participants (1)	Matched comparison group (2)	Difference (3)	Standard error (4)	Effect size (5)	Sample size (6)
Number of emergency room visits	1-year-olds	1.31	1.18	0.12**	0.03	0.077	17,291
	2-year-olds	0.98	0.88	0.10**	0.03	0.077	15,974
	3-year-olds	0.78	0.70	0.08**	0.02	0.067	15,780
	4-year-olds	0.69	0.60	0.09**	0.02	0.080	14,252
Number of dental care visits (comprehensive code list)	1-year-olds	0.09	0.08	0.01	0.01	0.029	17,291
	2-year-olds	0.07	0.06	0.01*	0.01	0.038	15,974
	3-year-olds	0.09	0.07	0.02*	0.01	0.049	15,780
	4-year-olds	0.09	0.09	0.00	0.01	0.002	14,252

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Oklahoma continuously enrolled from January to December 2010 linked with a Vital Records birth certificate. Outcomes are defined in Table IV.3.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in Chapter III. The propensity score model included the full set of covariates shown in Table IV.4.

Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

CHIPRA = Children's Health Insurance Program Reauthorization Act; EPSDT = Early Periodic Screening, Diagnosis, and Treatment; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table G.MO.7. Estimates of the association between any child WIC participation and recommended EPSDT visits in Missouri, by age cohort

Outcome	WIC participants (1)	Matched comparison group (2)	Difference (3)	Standard error (4)	Effect size (5)	Sample size[a] (6)
EPSDT visit at age 14–16 months	59.09	47.62	11.47**	0.60	0.232	20,185
EPSDT visit at age 17–19 months	67.87	51.77	16.10**	0.66	0.328	29,891
EPSDT visit at age 23–25 months	62.53	47.86	14.67**	0.72	0.295	29,089
EPSDT visit at ages 2–4 years	80.76	68.32	12.44**	0.51	0.286	56,319

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Missouri continuously enrolled from January to December 2010 linked with a Vital Records birth certificate. Outcomes are defined in Table IV.3.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in Chapter III. The propensity score model included the full set of covariates shown in Table IV.4.

Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

[a] Sample restricted to children observed at the ages when such visits would have occurred, plus or minus one month. For example, when analyzing the fraction of children with a "15-months" EPSDT visit, the analytic sample was restricted to children who were ages 14 to 16 months sometime in calendar year 2010.

EPSDT = Early Periodic Screening, Diagnosis, and Treatment; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table G.OK.7. Estimates of the association between any child WIC participation and recommended EPSDT visits in Oklahoma, by age cohort

Outcome	WIC participants (1)	Matched comparison group (2)	Difference (3)	Standard error (4)	Effect size (5)	Sample size[a] (6)
EPSDT visit at age 14–16 months	45.85	36.39	9.46**	0.80	0.192	18,644
EPSDT visit at age 17–19 months	46.91	39.65	7.26**	0.87	0.146	17,291
EPSDT visit at age 23–25 months	44.76	37.94	6.81**	0.91	0.138	16,559
EPSDT visit at ages 2–4 years	56.73	53.28	3.46**	0.71	0.069	32,490

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Oklahoma continuously enrolled from January to December 2010 linked with a Vital Records birth certificate.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in Chapter III. The propensity score model included the full set of covariates shown in Table IV.4.

Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

[a] Sample restricted to children observed at the ages when such visits would have occurred, plus or minus one month For example, when analyzing the fraction of children with a "15-months" EPSDT visit, the analytic sample was restricted to children who were ages 14 to 16 months sometime in calendar year 2010.

EPSDT = Early Periodic Screening, Diagnosis, and Treatment; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table G.MO.8. Estimates of the association between any child WIC participation and the diagnosis and treatment of common childhood illnesses in Missouri, by age cohort

Outcome	Age cohort	WIC participants (1)	Matched comparison group (2)	Difference (3)	Standard error (4)	Effect size (5)	Sample size (6))
Otitis media	1-year-olds	53.72	49.46	4.26**	0.70	0.085	29,891
	2-year-olds	39.22	32.84	6.38**	0.74	0.133	28,465
	3-year-olds	30.65	27.57	3.08**	0.78	0.068	27,032
	4-year-olds	25.23	20.80	4.44**	0.70	0.105	24,810
Upper respiratory infection	1-year-olds	69.35	61.47	7.89**	0.67	0.166	29,891
	2-year-olds	59.12	50.76	8.36**	0.77	0.168	28,465
	3-year-olds	53.06	45.66	7.40**	0.82	0.148	27,032
	4-year-olds	49.01	42.07	6.94**	0.84	0.139	24,810
Lower respiratory infection	1-year-olds	25.02	21.83	3.19**	0.59	0.075	29,891
	2-year-olds	17.22	13.63	3.59**	0.56	0.099	28,465
	3-year-olds	13.62	12.44	1.18*	0.60	0.035	27,032
	4-year-olds	12.55	9.71	2.84**	0.53	0.090	24,810
Asthma	1-year-olds	22.99	20.38	2.61**	0.58	0.063	29,891
	2-year-olds	21.45	16.11	5.34**	0.60	0.137	28,465
	3-year-olds	19.70	17.28	2.41**	0.66	0.062	27,032
	4-year-olds	21.01	16.76	4.25**	0.65	0.108	24,810
Iron deficiency anemia	1-year-olds	4.39	1.76	2.63**	0.22	0.152	29,891
	2-year-olds	3.25	0.99	2.26**	0.18	0.157	28,465
	3-year-olds	2.43	1.07	1.36**	0.19	0.104	27,032
	4-year-olds	1.86	0.87	0.99**	0.16	0.085	24,810
Gastroenteritis	1-year-olds	24.79	19.16	5.63**	0.57	0.136	29,891
	2-year-olds	18.10	14.49	3.61**	0.58	0.098	28,465
	3-year-olds	13.11	10.40	2.71**	0.54	0.084	27,032
	4-year-olds	10.63	7.98	2.65**	0.51	0.091	24,810
Allergy	1-year-olds	24.20	19.98	4.23**	0.59	0.102	29,891
	2-year-olds	21.68	16.95	4.74**	0.61	0.120	28,465
	3-year-olds	19.69	16.02	3.67**	0.65	0.096	27,032
	4-year-olds	20.72	16.47	4.25**	0.66	0.109	24,810

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Missouri continuously enrolled from January to December 2010 linked with a Vital Records birth certificate. Outcomes are defined in Table IV.3.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in Chapter III. The propensity score model included the full set of covariates shown in Table IV.4.

Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table G.OK.8. Estimates of the association between any child WIC participation and the diagnosis and treatment of common childhood illnesses in Oklahoma, by age cohort

Outcome	Age cohort	WIC participants (1)	Matched comparison group (2)	Difference (3)	Standard error (4)	Effect size (5)	Sample size (6))
Otitis media	1-year-olds	56.17	52.01	4.15**	0.90	0.083	17,291
	2-year-olds	40.39	36.88	3.52**	0.98	0.072	15,974
	3-year-olds	30.73	29.80	0.93	0.95	0.020	15,780
	4-year-olds	26.79	25.26	1.53	0.97	0.035	14,252
Upper respiratory infection	1-year-olds	70.51	67.00	3.51**	0.85	0.076	17,291
	2-year-olds	60.95	55.60	5.35**	1.00	0.108	15,974
	3-year-olds	53.18	50.66	2.52*	1.02	0.050	15,780
	4-year-olds	49.98	49.59	0.38	1.10	0.008	14,252
Lower respiratory infection	1-year-olds	26.09	27.47	-1.38	0.80	-0.031	17,291
	2-year-olds	18.68	17.78	0.90	0.76	0.023	15,974
	3-year-olds	15.11	13.96	1.14	0.70	0.032	15,780
	4-year-olds	13.17	13.10	0.07	0.74	0.002	14,252
Asthma	1-year-olds	22.98	22.91	0.07	0.75	0.002	17,291
	2-year-olds	21.64	21.20	0.44	0.83	0.011	15,974
	3-year-olds	21.38	19.38	2.00*	0.81	0.050	15,780
	4-year-olds	22.02	20.65	1.37	0.88	0.033	14,252
Iron deficiency anemia	1-year-olds	1.26	1.02	0.25	0.18	0.023	17,291
	2-year-olds	0.63	0.73	-0.10	0.18	-0.012	15,974
	3-year-olds	0.52	0.30	0.22*	0.11	0.034	15,780
	4-year-olds	0.32	0.27	0.05	0.10	0.009	14,252
Gastroenteritis	1-year-olds	27.60	25.11	2.49**	0.80	0.056	17,291
	2-year-olds	19.43	16.32	3.11**	0.76	0.081	15,974
	3-year-olds	14.89	13.86	1.03	0.73	0.029	15,780
	4-year-olds	12.28	11.97	0.31	0.74	0.010	14,252
Allergy	1-year-olds	30.92	28.71	2.20**	0.82	0.048	17,291
	2-year-olds	27.74	24.54	3.20**	0.88	0.073	15,974
	3-year-olds	25.63	22.59	3.04**	0.85	0.071	15,780
	4-year-olds	25.16	23.47	1.69	0.95	0.039	14,252

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Oklahoma continuously enrolled from January to December 2010 linked with a Vital Records birth certificate. Outcomes are defined in Table IV.3.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in Chapter III. The propensity score model included the full set of covariates shown in Table IV.4.

Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table G.MO.9. Estimates of the association between any child WIC participation and the secondary Medicaid cost outcomes in Missouri, by age cohort

Outcome	Age cohort	WIC participants (1)	Matched comparison group (2)	Difference (3)	Standard error (4)	Effect size (5)	Sample size (6))
Physician costs ($)[a]	1-year-olds	815	641	174	128	0.031	9,292
	2-year-olds	697	452	245*	107	0.048	9,004
	3-year-olds	66	939	-272	275	-0.033	8,599
	4-year-olds	907	600	307*	151	0.048	8,029
Outpatient costs ($)	1-year-olds	805	629	176**	34	0.132	9,292
	2-year-olds	666	500	166**	31	0.141	9,004
	3-year-olds	631	570	61	51	0.042	8,599
	4-year-olds	660	441	219**	35	0.161	8,029
Prescription drug costs ($)	1-year-olds	483	378	105**	33	0.079	9,292
	2-year-olds	359	239	120**	20	0.123	9,004
	3-year-olds	342	283	59	33	0.039	8,599
	4-year-olds	418	229	189**	33	0.134	8,029
Dental costs ($)	1-year-olds	19	15	4	4	0.025	9,292
	2-year-olds	56	42	13	9	0.041	9,004
	3-year-olds	78	74	5	12	0.013	8,599
	4-year-olds	105	106	-1	18	-0.002	8,029
EPSDT costs ($)	1-year-olds	340	281	59**	17	0.092	9,292
	2-year-olds	253	187	66**	17	0.093	9,004
	3-year-olds	235	210	25	23	0.033	8,599
	4-year-olds	298	178	120**	24	0.103	8,029
Well-child costs ($)	1-year-olds	368	304	64**	17	0.100	9,292
	2-year-olds	267	196	71**	17	0.099	9,004
	3-year-olds	251	222	28	23	0.038	8,599
	4-year-olds	318	191	127**	24	0.109	8,029
Inpatient costs ($)	1-year-olds	393	629	-236	287	-0.024	9,292
	2-year-olds	246	140	106	74	0.032	9,004
	3-year-olds	144	208	-64	73	-0.023	8,599
	4-year-olds	174	286	-112	220	-0.015	8,029
Emergency department costs ($)	1-year-olds	141	131	10	10	0.024	9,292
	2-year-olds	102	101	1	10	0.002	9,004
	3-year-olds	80	93	-13	9	-0.043	8,599
	4-year-olds	73	71	2	9	0.008	8,029
Physician (only) costs ($)	1-year-olds	418	375	44*	20	0.056	9,292
	2-year-olds	318	255	63**	17	0.110	9,004
	3-year-olds	282	278	4	26	0.004	8,599
	4-year-olds	324	231	93**	13	0.180	8,029

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Missouri continuously enrolled from January to December 2010 linked with a Vital Records birth certificate. Outcomes are defined in Table IV.3.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in Chapter III. The propensity score model included the full set of covariates shown in Table IV.4.

Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

The analysis of Medicaid costs includes only fee-for-service recipients. Approximately 68 percent of Medicaid recipients in Missouri are enrolled in Medicaid managed care. Managed care claims in Missouri do not include information about actual costs of services

[a] Includes the costs paid for physician claims and other carrier claims.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table G.OK.9. Estimates of the association between any child WIC participation and the secondary Medicaid cost outcomes in Oklahoma, by age cohort

Outcome	Age cohort	WIC participants (1)	Matched comparison group (2)	Difference (3)	Standard error (4)	Effect size (5)	Sample size (6))
Physician costs ($)	1-year-olds	1,153	1,106	47	45	0.017	17,291
	2-year-olds	886	1,051	-166	149	-0.037	15,974
	3-year-olds	929	947	-18	56	-0.006	15,780
	4-year-olds	1,094	1,070	23	64	0.007	14,252
Outpatient costs ($)	1-year-olds	312	299	13	15	0.015	17,291
	2-year-olds	241	242	-0	14	-0.001	15,974
	3-year-olds	210	222	-12	11	-0.022	15,780
	4-year-olds	208	216	-8	13	-0.014	14,252
Prescription drug costs ($)	1-year-olds	321	241	80	45	0.023	17,291
	2-year-olds	259	281	-21	103	-0.004	15,974
	3-year-olds	197	226	-29	39	-0.017	15,780
	4-year-olds	228	273	-45	52	-0.027	14,252
Dental costs ($)	1-year-olds	59	58	0	5	0.002	17,291
	2-year-olds	167	141	26*	10	0.052	15,974
	3-year-olds	272	227	45**	11	0.077	15,780
	4-year-olds	318	295	22	13	0.037	14,252
EPSDT costs ($)	1-year-olds	199	173	26**	3	0.175	17,291
	2-year-olds	78	68	10**	2	0.120	15,974
	3-year-olds	77	69	8**	2	0.098	15,780
	4-year-olds	79	71	7**	2	0.089	14,252
Well-child costs ($)	1-year-olds	221	191	30**	3	0.202	17,291
	2-year-olds	89	76	12**	2	0.146	15,974
	3-year-olds	88	80	8**	2	0.092	15,780
	4-year-olds	94	87	6**	2	0.072	14,252
Inpatient costs ($)	1-year-olds	328	506	-177*	80	-0.034	17,291
	2-year-olds	223	601	-378*	156	-0.061	15,974
	3-year-olds	159	332	-173	1010	-0.043	15,780
	4-year-olds	212	766	-554*	246	-0.066	14,252
Emergency department costs ($)	1-year-olds	160	153	7	4	0.030	17,291
	2-year-olds	120	114	6	5	0.027	15,974
	3-year-olds	98	88	10**	4	0.054	15,780
	4-year-olds	86	80	6	4	0.036	14,252
Physician (only) costs ($)	1-year-olds	868	792	76**	23	0.054	17,291
	2-year-olds	624	602	22	25	0.018	15,974
	3-year-olds	567	549	18	27	0.013	15,780
	4-year-olds	593	610	-18	39	-0.013	14,252

Outcome	Age cohort	WIC participants (1)	Matched comparison group (2)	Difference (3)	Standard error (4)	Effect size (5)	Sample size (6))
Other costs ($)	1-year-olds	6	3	3	3	0.013	17,291
	2-year-olds	1	4	-3	2	-0.024	15,974
	3-year-olds	1	1	-0	1	-0.011	15,780
	4-year-olds	1	1	1	1	0.015	14,252

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Oklahoma continuously enrolled from January to December 2010 linked with a Vital Records birth certificate. Outcomes are defined in Table IV.3.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in Chapter III. The propensity score model included the full set of covariates shown in Table IV.4.

Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table G.MO.10. Estimates of the association between any child WIC participation and the primary outcomes in Missouri, by mother's age at the time of birth and age cohort

Outcome	Age cohort	Age of mother at infant's birth: Less than or equal to 17 years (1)	Age of mother at infant's birth: Greater than 17 years (2)
Any well-child visits	1-year-olds	14.04** (2.96)	15.66** (0.67)
	2-year-olds	11.15** (3.38)	18.74** (0.75)
	3-year-olds	17.68** (4.07)	17.55** (0.79)
	4-year-olds	11.85** (4.18)	16.39** (0.82)
Any emergency room visits	1-year-olds	2.33 (3.07)	4.46** (0.68)
	2-year-olds	2.18 (3.37)	4.13** (0.73)
	3-year-olds	0.17 (3.82)	3.03** (0.75)
	4-year-olds	2.10 (3.47)	4.06** (0.73)
Any visit for the diagnosis and treatment of a common childhood illness[a] (%)	1-year-olds	4.73* (2.24)	6.79** (0.56)
	2-year-olds	0.59 (2.79)	9.18** (0.69)
	3-year-olds	0.00 (3.60)	7.86** (0.76)
	4-year-olds	9.68* (4.19)	8.15** (0.80)
Total Medicaid costs ($)[b]	1-year-olds	1,270 (705)	205 (365)
	2-year-olds	535* (230)	709** (161)
	3-year-olds	-299 (634)	-124 (336)
	4-year-olds	-97 (619)	489 (346)
Sample size		**7,145**	**103,050**

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Missouri continuously enrolled from January to December 2010 linked with a Vital Records birth certificate. Outcomes are defined in Table IV.3.

Each column presents the difference in outcomes between a group of WIC participants and a corresponding matched comparison group of nonparticipants, where the matched comparison group was constructed with inverse probability weighting, as described in Chapter III. The propensity score model

included the full set of covariates shown in Table IV.4 (with a few minor exceptions when small samples for certain subgroups did not permit the inclusion of rare characteristics). Models were estimated separately for each subgroup.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

[a] Otitis media (ear infection), upper respiratory infection, lower respiratory infection, asthma, iron deficiency anemia, gastroenteritis, or allergies.

[b] The analysis of Medicaid costs includes only fee-for-service recipients. Approximately 68 percent of Medicaid recipients in Missouri are enrolled in Medicaid managed care. Managed care claims in Missouri do not include information about actual costs of services.

IPW = inverse probability weighting; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table G.OK.10. Estimates of the association between any child WIC participation and the primary outcomes in Oklahoma, by mother's age at the time of birth and age cohort

Outcome	Age cohort	Age of mother at infant's birth: Less than or equal to 17 years (1)	Age of mother at infant's birth: Greater than 17 years (2)
Any well-child visits	1-year-olds	16.04** (3.44)	8.80** (0.87)
	2-year-olds	5.30 (3.93)	7.75** (0.94)
	3-year-olds	-1.36 (3.70)	7.75** (0.96)
	4-year-olds	5.82 (4.02)	4.83** (0.96)
Any emergency room visits	1-year-olds	-1.97 (3.47)	3.55** (0.87)
	2-year-olds	2.39 (4.02)	4.04** (0.96)
	3-year-olds	-1.14 (4.19)	3.27** (0.98)
	4-year-olds	9.14* (4.42)	3.91** (1.02)
Any visit for the diagnosis and treatment of a common childhood illness[a] (%)	1-year-olds	0.47 (2.55)	2.52** (0.65)
	2-year-olds	3.88 (3.62)	4.35** (0.85)
	3-year-olds	1.06 (3.82)	3.81** (0.92)
	4-year-olds	4.88 (4.23)	3.01** (0.99)
Total Medicaid costs ($)	1-year-olds	-1,017 (1,369)	-66 (137)
	2-year-olds	-2,225 (1,713)	-325 (194)
	3-year-olds	-1,188 (1,044)	-138 (134)
	4-year-olds	-576 (751)	-215 (185)
Sample size		**3,884**	**59,410**

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Oklahoma continuously enrolled from January to December 2010 linked with a Vital Records birth certificate. Outcomes are defined in Table IV.3.

Each column presents the difference in outcomes between a group of WIC participants and a corresponding matched comparison group of nonparticipants, where the matched comparison group was constructed with inverse probability weighting, as described in Chapter III. The propensity score model included the full set of covariates shown in Table IV.4 (with a few minor exceptions when small samples for

certain subgroups did not permit the inclusion of rare characteristics). Models were estimated separately for each subgroup.

Robust standard errors are in parenthesis. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

[a] Otitis media (ear infection), upper respiratory infection, lower respiratory infection, asthma, iron deficiency anemia, gastroenteritis, or allergies.

IPW = inverse probability weighting; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table G.MO.11. Estimates of the association between any child WIC participation and the primary outcomes in Missouri, by household income and age cohort

Outcome	Age cohort	Household income: Above or below FPL		Household income: Quantiles of household income			
		Less than 133% FPL (1)	Greater or equal to 133% FPL (2)	Quantile 1 (lowest) (3)	Quantile 2 (4)	Quantile 3 (5)	Quantile 4 (highest) (6)
Any well-child visits	1-year-olds	16.08** (0.66)	5.67* (2.79)	16.73** (0.88)	14.38** (2.65)	16.16** (1.42)	12.16** (1.43)
	2-year-olds	18.76** (0.77)	10.13** (2.75)	18.60** (1.25)	18.98** (2.58)	15.92** (1.47)	15.84** (1.43)
	3-year-olds	17.38** (0.82)	17.19** (3.06)	15.42** (1.34)	19.79** (2.61)	17.13** (1.50)	17.46** (1.54)
	4-year-olds	16.23** (0.85)	9.39** (2.91)	16.64** (1.41)	17.09** (2.51)	13.54** (1.60)	15.65** (1.56)
Any emergency room visits	1-year-olds	4.09** (0.68)	5.49 (2.84)	3.35** (0.93)	8.30** (2.61)	5.59** (1.42)	3.17* (1.44)
	2-year-olds	4.43** (0.74)	-1.86 (2.67)	4.80** (1.24)	5.25* (2.47)	2.98* (1.41)	2.67* (1.36)
	3-year-olds	2.98** (0.77)	4.28 (2.74)	2.91* (1.29)	5.52* (2.41)	1.58 (1.40)	2.00 (1.42)
	4-year-olds	3.96** (0.77)	5.06* (2.44)	2.25 (1.33)	8.72** (2.12)	5.42** (1.38)	3.69** (1.37)
Any visit for the diagnosis and treatment of a common childhood illness[a] (%)	1-year-olds	6.73** (0.56)	4.76* (2.38)	6.24** (0.74)	8.08** (2.24)	8.26** (1.24)	5.27** (1.19)
	2-year-olds	9.31** (0.71)	3.92 (2.42)	7.60** (1.14)	9.97** (2.37)	9.25** (1.35)	7.35** (1.30)
	3-year-olds	7.79** (0.78)	0.73 (2.63)	5.63** (1.26)	11.08** (2.49)	7.05** (1.42)	5.43** (1.44)
	4-year-olds	8.13** (0.83)	4.08 (2.80)	9.19** (1.39)	9.59** (2.54)	5.37** (1.52)	6.10** (1.51)
Total Medicaid costs[b] ($)	1-year-olds	206 (397)	897 (750)	377[c] (742)	856** (171)	854** (296)	-474 (560)
	2-year-olds	678** (162)	212 (252)	750** (188)	959 (522)	847** (266)	168 (331)
	3-year-olds	-156 (355)	329 (193)	-515[c] (863)	269 (263)	-862 (1,123)	-349 (609)
	4-year-olds	306 (274)	860 (462)	659 (486)	899* (429)	-10 (516)	417 (249)
Sample size		**100,745**	**6,868**	**44,793[d]**	**9,021[d]**	**26,932**	**26,867**
Minimum/maximum income (as percentage of FPL) in subgroup		0/132	133/299	0/0	1/19	20/83	83/299

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Missouri continuously enrolled from January to December 2010 linked with a Vital Records birth certificate. Outcomes are defined in Table IV.3.

Each column presents the difference in outcomes between a group of WIC participants and a corresponding matched comparison group of nonparticipants, where the matched comparison group was constructed with inverse probability weighting, as described in Chapter III. The propensity score model included the full set of covariates shown in Table IV.4 (with a few minor exceptions when small samples for certain subgroups did not permit the inclusion of rare characteristics). Models were estimated separately for each subgroup.

Robust standard errors are in parenthesis. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

[a] Otitis media (ear infection), upper respiratory infection, lower respiratory infection, asthma, iron deficiency anemia, gastroenteritis, or allergies.

[b] The analysis of Medicaid costs includes only fee-for-service recipients. Approximately 68 percent of Medicaid recipients in Missouri are enrolled in Medicaid managed care. Managed care claims in Missouri do not include information about actual costs of services.

[c] The IPW model had trouble converging when computing standard errors, but there are no reasons to suspect this result is incorrect. A regression model yielded an estimate of $879 (standard error $570) for the 1-year-old cohort and $154 (standard error $556) for the 3-year-old cohort.

[d] The quantiles are not equally sized due to ties.

FPL = Federal poverty level; IPW = inverse probability weighting; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table G.OK.11. Estimates of the association between any child WIC participation and the primary outcomes in Oklahoma, by household income and age cohort

Outcome	Age cohort	Household income: Above or below FPL		Household income: Quantiles of household income			
		Less than 133% FPL (1)	Greater or equal to 133% FPL (2)	Quantile 1 (Lowest) (3)	Quantile 2 (4)	Quantile 3 (5)	Quantile 4 (Highest) (6)
Any well-child visits	1-year-olds	8.97** (0.82)	7.94** (2.84)	8.15** (1.44)	10.05** (1.59)	9.03** (1.68)	8.80** (1.64)
	2-year-olds	7.72** (0.96)	7.40* (3.04)	6.26** (1.83)	7.41** (1.81)	8.13** (1.90)	8.29** (1.83)
	3-year-olds	7.56** (0.98)	3.37 (3.03)	6.22** (1.92)	8.33** (1.81)	6.42** (1.94)	6.67** (1.88)
	4-year-olds	4.95** (0.99)	4.29 (2.95)	6.40** (1.95)	2.94 (1.81)	4.43* (1.94)	5.43** (1.81)
Any emergency room visits	1-year-olds	2.31** (0.88)	8.21** (3.01)	1.78 (1.51)	3.90* (1.68)	-0.41 (1.79)	5.40** (1.79)
	2-year-olds	3.99** (0.98)	0.12 (3.15)	5.21** (1.86)	4.18* (1.85)	3.34 (1.97)	1.14 (1.88)
	3-year-olds	3.00** (1.00)	1.29 (3.14)	2.80 (1.98)	4.94** (1.85)	-0.10 (2.00)	3.31 (1.88)
	4-year-olds	3.68** (1.05)	8.85** (2.92)	4.80* (2.09)	3.22 (1.97)	2.70 (2.06)	5.36** (1.87)
Any visit for the diagnosis and treatment of a common childhood illness[a] (%)	1-year-olds	2.52** (0.65)	1.37 (2.16)	0.71 (1.10)	6.42** (1.36)	1.45 (1.24)	0.76 (1.30)
	2-year-olds	4.08** (0.86)	4.14 (2.75)	4.20** (1.63)	5.93** (1.69)	4.01* (1.71)	1.43 (1.56)
	3-year-olds	3.68** (0.94)	3.06 (2.90)	3.71* (1.83)	2.61 (1.75)	2.04 (1.83)	5.39** (1.81)
	4-year-olds	2.90** (1.02)	7.92* (3.18)	2.96 (1.99)	2.69 (1.91)	3.29 (2.01)	3.40 (1.86)
Total Medicaid costs ($)	1-year-olds	-118 (139)	241 (629)	-746 (430)	172 (147)	-255 (272)	233 (251)
	2-year-olds	-306 (191)	-1,392[b] (1,077)	-527 (330)	243 (291)	-764 (544)	-554 (457)
	3-year-olds	-159 (136)	-220 (472)	-580 (297)	192 (145)	-667 (440)	-7 (207)
	4-year-olds	-250 (187)	-152 (310)	-672 (504)	-793 (470)	162 (257)	202 (148)
Sample size		**58,035**	**5,255**	**15,964**	**15,931**	**15,894**	**15,501**
Minimum/ maximum income (as percentage of FPL) in subgroup		0/132	133/247	0/3	4/53	54/91	92/247

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Oklahoma continuously enrolled from January to December 2010 linked with a Vital Records birth certificate. Outcomes are defined in Table IV.3.

Each column presents the difference in outcomes between a group of WIC participants and a corresponding matched comparison group of nonparticipants, where the matched comparison group was constructed with inverse probability weighting, as described in Chapter III. The propensity score model included the full set of covariates shown in Table IV.4 (with a few minor exceptions when small samples for certain subgroups did not permit the inclusion of rare characteristics). Models were estimated separately for each subgroup.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

[a]Otitis media (ear infection), upper respiratory infection, lower respiratory infection, asthma, iron deficiency anemia, gastroenteritis, or allergies.

[b] The IPW model had trouble converging when computing standard errors, but there are no reasons to suspect this result is incorrect. A regression model yielded an estimate of -$1,464 (standard error $1,144).

FPL = Federal poverty level; IPW = inverse probability weighting; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table G.MO.12. Estimates of the association between any child WIC participation and the primary outcomes in Missouri, by quantile of the propensity score distribution

	Any well-child visits				Any emergency room visits			
	1-year-olds	2-year-olds	3-year-olds	4-year-olds	1-year-olds	2-year-olds	3-year-olds	4-year-olds
Quantile 1	13.062 (1.428)**	12.448 (1.647)**	10.960 (1.768)**	9.325 (1.832)**	4.908 (1.596)**	4.469 (1.681)**	6.821 (1.683)**	5.022 (1.745)**
Quantile 2	14.600 (1.652)**	12.773 (1.796)**	13.424 (1.908)**	10.594 (1.989)**	5.186 (1.724)**	6.201 (1.825)**	6.561 (1.848)**	5.496 (1.880)**
Quantile 3	16.556 (1.778)**	15.538 (1.904)**	12.416 (2.020)**	12.598 (2.113)**	3.513 (1.831)	4.224 (1.915)*	1.981 (1.978)	0.871 (1.954)
Quantile 4	13.442 (1.885)**	17.114 (2.044)**	15.456 (2.250)**	14.638 (2.271)**	2.710 (1.973)	7.138 (2.021)**	3.628 (2.194)	5.315 (2.060)**
Quantile 5	14.128 (1.941)**	8.956 (2.239)**	17.268 (2.323)**	14.064 (2.384)**	4.727 (2.054)*	3.825 (2.310)	1.303 (2.294)	4.841 (2.232)*
Quantile 6	18.366 (2.077)**	16.715 (2.377)**	16.887 (2.467)**	14.855 (2.474)**	5.833 (2.132)**	4.698 (2.395)*	3.194 (2.410)	2.722 (2.351)
Quantile 7	15.377 (2.192)**	15.788 (2.470)**	16.573 (2.549)**	20.323 (2.634)**	3.854 (2.221)	2.825 (2.461)	0.401 (2.464)	0.630 (2.458)
Quantile 8	17.128 (2.417)**	24.679 (2.664)**	23.414 (2.709)**	23.559 (3.060)**	2.035 (2.445)	1.160 (2.572)	-1.824 (2.543)	5.563 (2.744)*
Quantile 9	17.683 (2.692)**	25.819 (3.116)**	23.572 (3.454)**	11.447 (3.469)**	5.795 (2.688)*	4.158 (3.007)	6.165 (3.082)*	7.004 (3.078)*
Quantile 10	11.734 (3.221)**	19.418 (3.616)**	16.781 (4.067)**	15.605 (4.159)**	3.571 (3.235)	-1.675 (3.527)	-1.115 (3.942)	3.846 (3.565)
Quantiles 1-10	15.208 (0.692)**	16.924 (0.777)**	16.675 (0.835)**	14.701 (0.862)**	4.213 (0.708)**	3.702 (0.769)**	2.712 (0.798)**	4.131 (0.780)**
Test: Associations do not vary across the 10 quantiles								
chi-squared	9.00	39.19	25.24	26.16	3.06	7.86	16.24	7.53
p-value	0.437	0.000	0.003	0.002	0.962	0.549	0.062	0.582
Sample size	29,891	28,465	27,032	24,810	29,891	28,465	27,032	24,810

	Any visit for the diagnosis and treatment of a common childhood illness (%)a				Total Medicaid costs ($)b			
	1-year-olds	2-year-olds	3-year-olds	4-year-olds	1-year-olds	2-year-olds	3-year-olds	4-year-olds
Quantile 1	6.537 (1.299)**	5.530 (1.632)**	11.110 (1.801)**	6.632 (1.894)**	1,713 (742)*	608 (573)	-292 (597)	505 (865)
Quantile 2	7.202 (1.432)**	9.945 (1.758)**	10.341 (1.931)**	6.977 (2.009)**	1,019 (634)	1,359 (570)*	-302 (807)	-1,066 (2,060)
Quantile 3	7.863 (1.513)**	9.275 (1.831)**	4.699 (2.009)*	8.418 (2.120)**	656 (611)	983 (520)	-206 (833)	1,761 (695)*
Quantile 4	8.056 (1.575)**	12.020 (1.953)**	5.463 (2.182)*	8.866 (2.270)**	446 (208)*	517 (184)**	-1,664 (1,834)	363 (651)
Quantile 5	4.704 (1.567)**	9.412 (2.152)**	4.271 (2.200)	7.032 (2.348)**	-1,628 (2,257)	712 (446)	1,169 (414)**	1,370 (448)**
Quantile 6	6.365 (1.692)**	8.934 (2.190)**	3.827 (2.316)	8.070 (2.450)**	-1,368 (2,499)	-106 (807)	783 (524)	-39 (1,124)
Quantile 7	3.955 (1.716)*	9.567 (2.287)**	6.448 (2.419)**	6.386 (2.561)*	1,022 (455)*	488 (194)*	500 (160)**	859 (391)*
Quantile 8	5.223 (1.903)**	3.653 (2.326)	8.364 (2.601)**	8.143 (2.977)**	-1,306 (1,535)	513 (407)	-1,919 (2,469)	1,192 (341)**
Quantile 9	8.018 (2.124)**	8.545 (2.749)**	6.637 (3.203)*	9.682 (3.464)**	-85 (489)	-24 (714)	-1,530 (2,212)	1,123 (373)**
Quantile 10	7.941 (2.625)**	6.539 (3.143)*	6.961 (3.787)	11.666 (4.120)**	1,528 (496)**	1,574 (415)**	697 (529)	55 (587)
Quantiles 1-10	6.586 (0.564)**	8.342 (0.710)**	6.812 (0.795)**	8.187 (0.855)**	200 (397)	662 (164)**	-276 (410)	613 (285)*
Test: Associations do not vary across the 10 quantiles								
chi-squared	6.80	12.58	13.74	2.46	12.69	9.96	9.70	8.13
p-value	0.657	0.182	0.132	0.982	0.177	0.354	0.376	0.521
Sample size	29,891	28,465	27,032	24,810	9,292	9,004	8,599	8,029

Source: WM-II database for Missouri constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Missouri continuously enrolled from January to December 2010 linked with a Vital Records birth certificate. Outcomes are defined in Table IV.3.

Subclassification on the propensity score was used to check for heterogeneity in the associations between WIC participation and study outcomes between children who were statistically more or less likely to participate in WIC after their first birthday. In this analysis, the sample was partitioned into 10 subclasses based on quantiles of the estimated propensity scores. The propensity score model included the full set of covariates shown in Table IV.4. Mean outcomes for WIC participants and nonparticipants then were compared within each subclass. Inverse probability weights were not applied for this analysis, because the propensity scores are approximately constant within each subclass (Imbens and Rubin 2015, ch. 17).

Robust standard errors, in parentheses, were computed in Stata using a custom program to estimate a system of equations by generalized method of moments. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

The final row includes chi-squared test statistics and *p*-values for the hypothesis test that associations between WIC participation and the primary outcome measures were the same across all 10 subclasses.

[a] Otitis media (ear infection), upper respiratory infection, lower respiratory infection, asthma, iron deficiency anemia, gastroenteritis, or allergies.

[b] The analysis of Medicaid costs includes only fee-for-service recipients. Approximately 68 percent of Medicaid recipients in Missouri are enrolled in Medicaid managed care. Managed care claims in Missouri do not include information about actual costs of services.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table G.OK.12. Estimates of the association between any child WIC participation and the primary outcomes in Oklahoma, by quantile of the propensity score distribution

	Any well-child visits				Any emergency room visits			
	1-year-olds	2-year-olds	3-year-olds	4-year-olds	1-year-olds	2-year-olds	3-year-olds	4-year-olds
Quantile 1	8.393 (1.891)**	6.426 (2.284)**	6.075 (2.339)**	6.021 (2.335)**	6.968 (2.120)**	3.515 (2.339)	5.756 (2.333)*	7.336 (2.356)**
Quantile 2	7.486 (2.176)**	7.914 (2.481)**	6.889 (2.499)**	7.632 (2.533)**	3.193 (2.319)	3.291 (2.551)	1.544 (2.507)	7.422 (2.639)**
Quantile 3	4.947 (2.285)*	5.540 (2.578)*	4.759 (2.734)	1.963 (2.629)	6.362 (2.378)**	5.726 (2.622)*	5.733 (2.757)*	3.433 (2.790)
Quantile 4	8.140 (2.354)**	6.885 (2.687)*	9.877 (2.806)**	4.246 (2.847)	4.232 (2.411)	1.179 (2.744)	4.609 (2.829)	4.320 (2.955)
Quantile 5	6.308 (2.479)*	5.315 (2.683)*	10.864 (2.814)**	9.182 (2.914)**	4.122 (2.508)	2.883 (2.763)	4.362 (2.828)	6.534 (3.034)*
Quantile 6	7.165 (2.589)**	12.662 (3.049)**	5.627 (2.989)	-4.101 (2.854)	2.110 (2.639)	8.198 (3.108)**	7.017 (3.088)*	6.052 (3.183)
Quantile 7	6.768 (2.757)*	4.450 (3.039)	7.868 (3.009)**	7.880 (3.169)*	5.595 (2.780)*	4.883 (3.149)	3.546 (3.112)	5.311 (3.380)
Quantile 8	12.296 (2.903)**	7.245 (3.243)*	-0.091 (3.186)	1.273 (3.191)	5.038 (3.027)	5.383 (3.300)	-0.016 (3.460)	0.978 (3.546)
Quantile 9	6.688 (3.372)*	4.713 (4.140)	-2.028 (3.819)	0.808 (3.965)	-8.699 (3.601)*	1.566 (4.350)	0.564 (4.066)	1.514 (4.318)
Quantile 10	21.924 (4.478)**	12.726 (4.587)**	8.446 (4.500)	6.430 (4.673)	0.678 (4.518)	3.785 (4.700)	1.716 (4.647)	-3.107 (5.054)
Quantiles 1-10	9.011 (0.891)**	7.388 (0.998)**	5.829 (0.990)**	4.133 (1.006)**	2.960 (0.921)**	4.041 (1.027)**	3.483 (1.023)**	3.980 (1.079)**
Test: Associations do not vary across the 10 quantiles								
chi-squared	14.67	6.93	13.95	17.70	17.01	4.17	5.25	7.08
p-value	0.100	0.644	0.124	0.039	0.049	0.900	0.812	0.629
Sample size	17,291	15,974	15,780	14,252	17,291	15,974	15,780	14,252

	Any visit for the diagnosis and treatment of a common childhood illness (%)a				Total Medicaid costs ($)b			
	1-year-olds	2-year-olds	3-year-olds	4-year-olds	1-year-olds	2-year-olds	3-year-olds	4-year-olds
Quantile 1	4.225 (1.403)**	2.263 (1.952)	4.179 (2.182)	3.758 (2.368)	-1,159 (655)	-939 (526)	-143 (369)	254 (257)
Quantile 2	3.156 (1.523)*	2.509 (2.147)	4.778 (2.365)*	6.633 (2.616)*	-27 (313)	-164 (249)	452 (272)	-79 (480)
Quantile 3	3.570 (1.735)*	8.819 (2.375)**	-2.066 (2.537)	4.867 (2.731)	199 (324)	-352 (490)	-453 (371)	549 (201)**
Quantile 4	1.114 (1.697)	3.846 (2.429)	9.300 (2.726)**	2.618 (2.952)	-331 (449)	-642 (900)	237 (325)	157 (667)
Quantile 5	6.424 (1.870)**	3.267 (2.323)	3.128 (2.630)	6.363 (3.031)*	75 (267)	-17 (439)	-594 (536)	-817 (924)
Quantile 6	2.671 (1.900)	7.116 (2.739)**	4.872 (2.859)	3.815 (3.034)	-596 (593)	7 (329)	286 (243)	-165 (341)
Quantile 7	1.941 (2.116)	2.984 (2.624)	7.583 (2.862)**	6.576 (3.147)*	81 (611)	-574 (726)	-634 (633)	-313 (358)
Quantile 8	7.976 (2.472)**	6.313 (2.893)*	4.837 (3.238)	-3.903 (3.239)	450 (242)	-254 (821)	-36 (221)	-819 (998)
Quantile 9	-1.932 (2.720)	7.666 (4.169)	4.494 (4.132)	6.215 (4.588)	301 (457)	-1,036 (1,575)	-651 (1,016)	-3,778 (2,891)
Quantile 10	-2.981 (3.354)	6.026 (4.464)	1.380 (4.614)	0.686 (4.945)	466 (246)	-1,808 (1,881)	-259 (376)	-389 (286)
Quantiles 1-10	2.616 (0.682)**	5.081 (0.924)**	4.249 (0.982)**	3.763 (1.063)**	-54 (140)	-578 (298)	-180 (156)	-540 (336)
Test: Associations do not vary across the 10 quantiles								
chi-squared	16.18	8.17	11.69	9.26	10.42	4.10	9.41	13.97
p-value	0.063	0.517	0.231	0.414	0.318	0.905	0.400	0.123
Sample size	17,291	15,974	15,780	14,252	17,291	15,974	15,780	14,252

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Oklahoma continuously enrolled from January to December 2010 linked with a Vital Records birth certificate.

Subclassification on the propensity score was used to check for heterogeneity in the associations between WIC participation and study outcomes between children who were statistically more or less likely to participate in WIC after their first birthday. In this analysis, the sample was partitioned into 10 subclasses based on quantiles of the estimated propensity scores. The propensity score model included the full set of covariates shown in Table IV.4. Mean outcomes for WIC participants and nonparticipants then were compared within each subclass. Inverse probability weights were not applied for this analysis, because the propensity scores are approximately constant within each subclass (Imbens and Rubin 2015, ch. 17). Outcomes are defined in Table IV.3.

Robust standard errors, in parentheses, were computed in Stata using a custom program to estimate a system of equations by generalized method of moments. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

The final row includes chi-squared test statistics and *p*-values for the hypothesis test that associations between WIC participation and the primary outcome measures were the same across all 10 subclasses.

[a] Otitis media (ear infection), upper respiratory infection, lower respiratory infection, asthma, iron deficiency anemia, gastroenteritis, or allergies.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

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APPENDIX H

CHILDREN'S ANALYSIS ROBUSTNESS CHECKS AND SENSITIVITY ANALYSES

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The study team conducted a number of analyses to assess the robustness of the findings from the children's analysis (Chapter V) and explore implications of data limitations on the generalizability of results. This appendix discusses some of these checks.

A. Alternative model specifications

The study team compared the results in this study—obtained with inverse probability weighting (IPW) methods—to the results of several alternative model specifications, such as using regression adjustment to control for selection biases. There were relatively few substantive differences between findings derived from IPW and from multivariate regressions.

B. Alternative measures of Medicaid costs

The study team conducted analyses using transformed measures of Medicaid costs: measures of costs not prorated when claims ended after December 2010, Winsorized (trimmed) measures of total Medicaid costs, and the logarithm of costs. Table H.1 presents results from these analyses. When the study team reestimated the models using Winsorized (trimmed) measures of Medicaid costs or the logarithm of costs, the results were considerably different than results with untransformed measures of Medicaid costs (particularly in Oklahoma). As discussed in Chapter V, Section V.B.3, this suggests that outliers might be partially driving the results with untransformed measures of Medicaid costs.

C. Shifts in the distribution of Medicaid costs

The study team calculated differences in costs between child WIC participants and nonparticipants across the distribution of Medicaid costs, from the 5th to the 95th percentiles, in increments of 5 percent (Figure H.1).

In Missouri, the estimated quantile treatment effect models for each cohort indicate that WIC participation was associated with higher Medicaid costs (that is, the estimate is positive) for most quantiles (that is, most children) in all four age cohorts. This indicates that savings in Medicaid costs were not concentrated among the children with the highest costs, but were widespread across most the sample. However, estimates tended to be larger for the upper quantiles, which is not surprising. (The top quantile is represented by the data point farthest to the right in the graph.) The estimate at the very top of the distribution (the top quantile) was imprecisely estimated for the 3-year-olds and thus should be interpreted with caution.

In Oklahoma, quantile treatment effect models also indicate that WIC participation was associated with higher Medicaid costs for most quantiles (that is, most children) in all four age cohorts, but not necessarily for the highest-cost quantiles. Estimates for the highest quantiles are uncertain—standard errors are very large for the upper quantiles. For the 2-year-old and 4-year-old cohorts, the estimates were below zero, suggesting that the reason WIC participants in Oklahoma had *lower* average Medicaid costs was due to differences between the two groups in the upper tail of the cost distribution. For the rest of the cost distribution, WIC participation was associated with higher Medicaid costs, similar to the results from Missouri.

D. Managed care beneficiaries in Missouri

Two sets of additional analyses addressed the limitation of the Missouri data, discussed in Chapter IV, that the Medicaid claims data do not include costs for beneficiaries enrolled in Medicaid managed care (about 68 percent of children). First, the characteristics of managed care beneficiaries (for whom costs are unavailable) and fee-for-service beneficiaries (for whom Medicaid costs are available) were compared on characteristics from the birth certificates and Medicaid eligibility files (Table H.MO.2). Second, to further assess how costs may have differed between fee-for-service and Medicaid managed care beneficiaries, subgroup analysis with the health care utilization measures was conducted separately for the fee-for-service and managed care Medicaid beneficiaries (Table H.MO.3). Chapter V, Section V.C.3, discusses the results from these analyses.

E. Native American beneficiaries in Oklahoma

Due to challenges encountered in obtaining data from WIC Indian Tribal Organization (ITO) agencies and Medicaid data for Native Americans, this study's findings are only generalizable to non–Native American children who participate in WIC through the State or one of the seven participating ITOs. Although Medicaid claims data were unavailable for Native Americans, the Native Americans and Medicaid beneficiaries of other races could be compared on characteristics from the birth certificates and Medicaid eligibility files. Table H.OK.4 presents these comparisons. The table reveals a few statistically significant differences between these groups: the mothers of Native American children were more likely to be married and less likely to have a short inter-pregnancy interval, and Native American children were more likely to be born with low or very low birthweight and less likely to live in a rural area. Given the presence of these differences between the two populations, it is not clear whether estimates of the association between WIC participation and the study outcomes would be larger or smaller if the analysis sample had included Native American children.

Table H.MO.1. Estimates of the association between any child WIC participation and the Medicaid costs in Missouri (when costs after December 31 are not prorated or costs are Winsorized), by age cohort

Outcome	Age cohort	WIC participants (1)	Matched comparison group (2)	Difference (3)	Standard error (4)	Sample size (5)
Medicaid costs: Did not prorate claims with end dates in 2011						
Total Medicaid costs ($, not prorated)	1-year-olds	2,491	2,258	233	364	9,292
	2-year-olds	1,965	1,330	635**	160	9,004
	3-year-olds	1,781	1,970	-189	329	8,599
	4-year-olds	2,157	1,555	602*	286	8,029
Winsorized (trimmed) Medicaid costs						
Total costs ($), Winsorized at $200,000	1-year-olds	2,378	2,023	355	229	9,292
	2-year-olds	1,931	1,331	601**	153	9,004
	3-year-olds	1,745	1,952	-207	319	8,599
	4-year-olds	2,132	1,418	715**	203	8,029
Total costs ($), Winsorized at $100,000	1-year-olds	2,219	1,857	362*	152	9,292
	2-year-olds	1,806	1,316	490**	133	9,004
	3-year-olds	1,651	1,696	-46	211	8,599
	4-year-olds	1,974	1,332	642**	156	8,029
Total costs ($), Winsorized at $75,000	1-year-olds	2,162	1,788	374**	126	9,292
	2-year-olds	1,747	1,297	450**	122	9,004
	3-year-olds	1,608	1,574	34	168	8,599
	4-year-olds	1,901	1,275	626**	131	8,029
Total costs ($), Winsorized at $50,000	1-year-olds	2,093	1,719	374**	103	9,292
	2-year-olds	1,662	1,268	394**	108	9,004
	3-year-olds	1,539	1,440	99	126	8,599
	4-year-olds	1,801	1,204	597**	106	8,029
Logarithm of costs	1-year-olds	6.90	6.33	0.57**	0.06	9,292
	2-year-olds	6.34	5.61	0.73**	0.09	9,004
	3-year-olds	6.13	5.43	0.71**	0.10	8,599
	4-year-olds	6.27	5.46	0.81**	0.09	8,029

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Missouri continuously enrolled from January to December 2010 linked with a Vital Records birth certificate. Outcomes are defined in Table IV.3.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in Chapter III. The propensity score model included the full set of covariates shown in Table IV.4.

Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

The analysis of Medicaid costs includes only fee-for-service recipients. Approximately 68 percent of Medicaid recipients in Missouri are enrolled in Medicaid managed care. Managed care claims in Missouri do not include information about actual costs of services.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table H.OK.1. Estimates of the association between any child WIC participation and the Medicaid costs in Oklahoma (when costs after December 31 are not prorated or costs are Winsorized), by age cohort

Outcome	Age cohort	WIC participants (1)	Matched comparison group (2)	Difference (3)	Standard error (4)	Sample size (5)
Medicaid costs: Did not prorate claims with end dates in 2011						
Total Medicaid costs ($, not prorated)	1-year-olds	2,162	2,194	-32	130	17,291
	2-year-olds	1,742	2,289	-547*	277	15,974
	3-year-olds	1,723	1,921	-197	152	15,780
	4-year-olds	2,017	2,581	-564	317	14,252
Winsorized (trimmed) Medicaid costs						
Total costs ($), Winsorized at $200,000	1-year-olds	2,126	2,162	-36	114	17,291
	2-year-olds	1,707	2,190	-483*	237	15,974
	3-year-olds	1,722	1,919	-197	151	15,780
	4-year-olds	2,006	2,455	-449	250	14,252
Total costs ($), Winsorized at $100,000	1-year-olds	2,070	2,060	11	87	17,291
	2-year-olds	1,662	1,896	-233	131	15,974
	3-year-olds	1,695	1,807	-112	108	15,780
	4-year-olds	1,933	2,144	-211	138	14,252
Total costs ($), Winsorized at $75,000	1-year-olds	2,042	2,016	26	78	17,291
	2-year-olds	1,636	1,812	-176	105	15,974
	3-year-olds	1,679	1,761	-82	93	15,780
	4-year-olds	1,904	2,064	-161	113	14,252
Total costs ($), Winsorized at $50,000	1-year-olds	1,997	1,950	47	68	17,291
	2-year-olds	1,602	1,706	-104	80	15,974
	3-year-olds	1,657	1,696	-39	77	15,780
	4-year-olds	1,864	1,966	-102	87	14,252
Logarithm of costs	1-year-olds	6.85	6.55	0.30**	0.04	17,291
	2-year-olds	6.35	6.03	0.32**	0.05	15,974
	3-year-olds	6.35	6.02	0.33**	0.05	15,780
	4-year-olds	6.54	6.32	0.22**	0.06	14,252

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

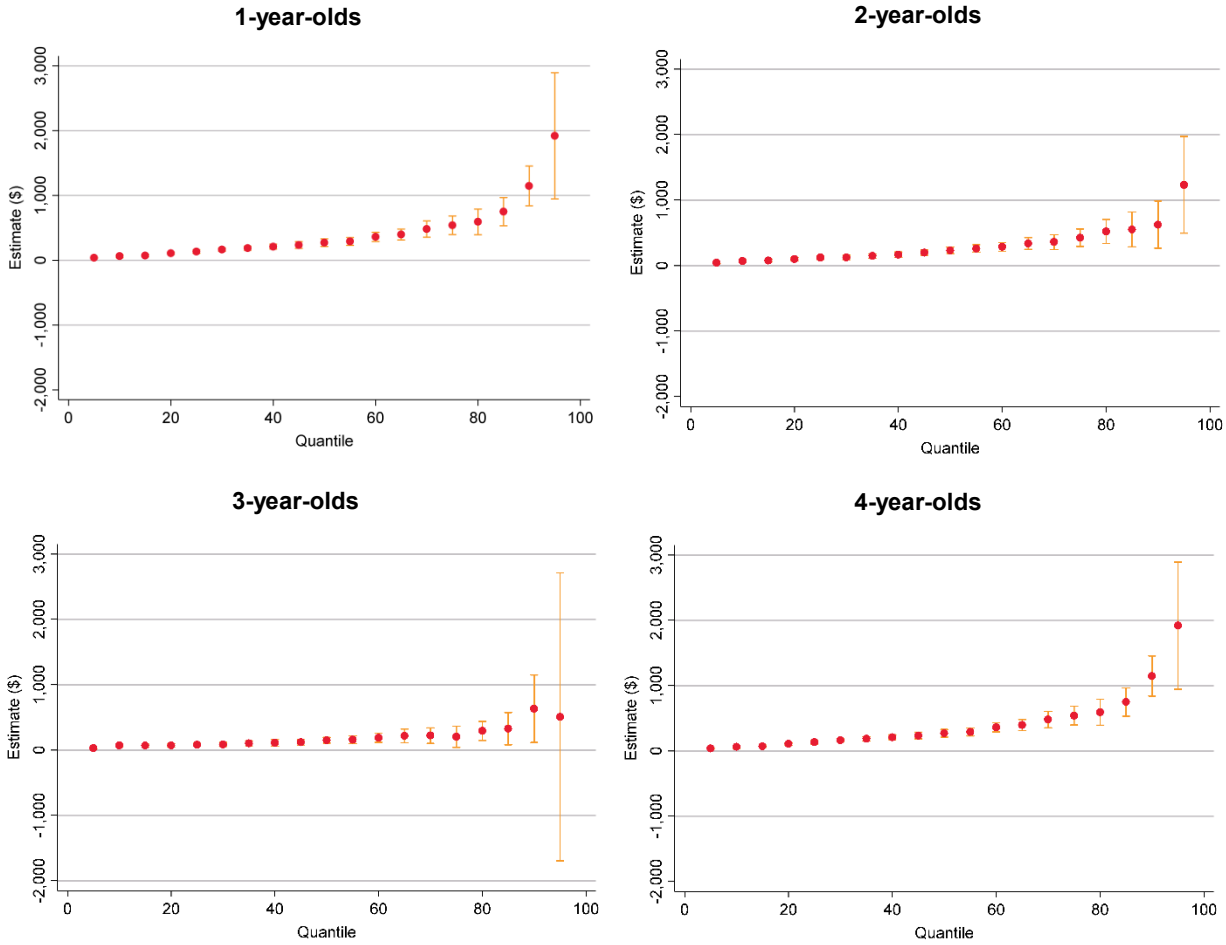
Notes: Based on Medicaid beneficiaries in Oklahoma continuously enrolled from January to December 2010 linked with a Vital Records birth certificate. Outcomes are defined in Table IV.3.

The matched comparison group of nonparticipants was constructed with inverse probability weighting, as described in Chapter III. The propensity score model included the full set of covariates shown in Table IV.4.

Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels, where tests for statistical significance did *not* account for multiple comparisons.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Figure H.MO.1. Estimates of the association between any child WIC participation and total Medicaid costs in Missouri, by age cohort and quantile



Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

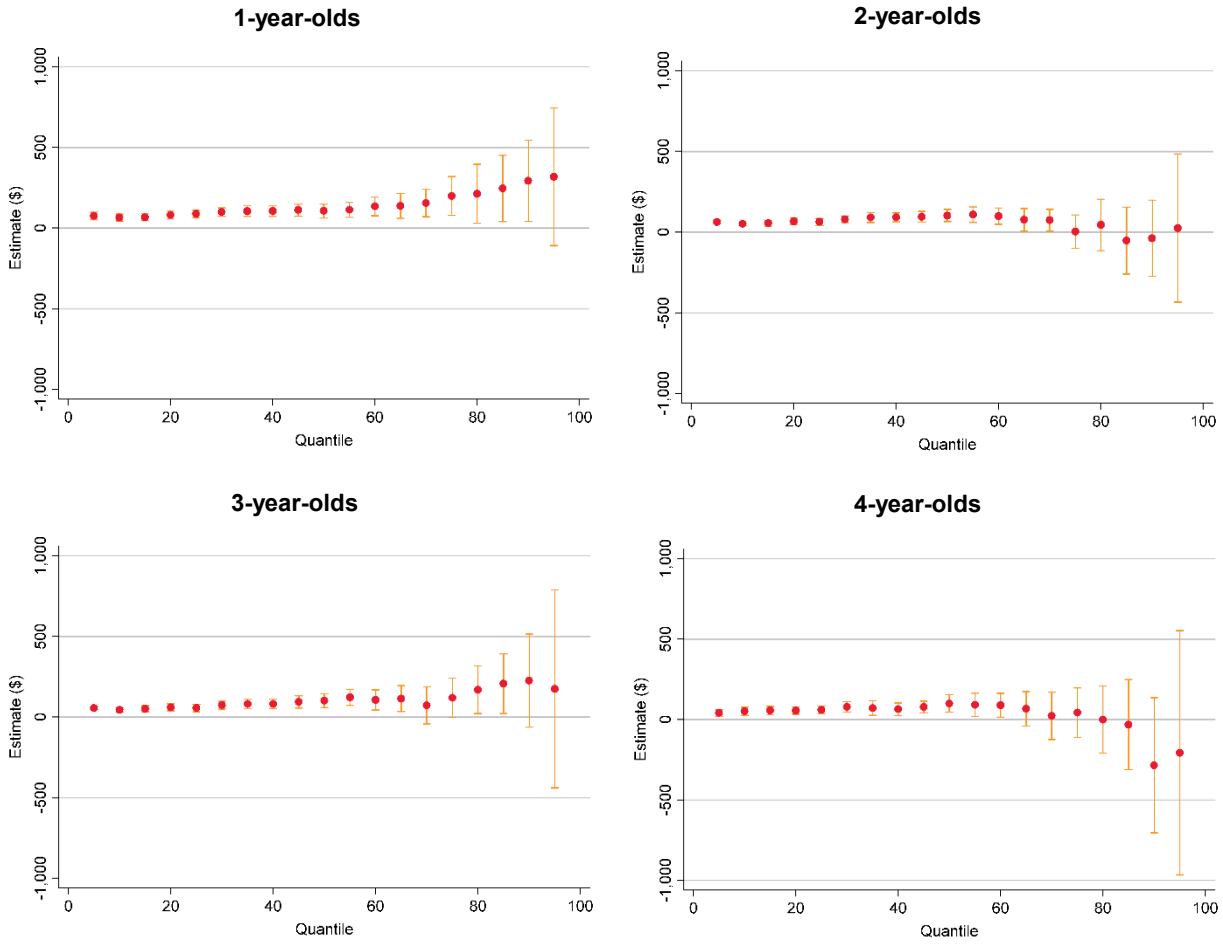
Notes: Based on Medicaid beneficiaries in Missouri continuously enrolled from January to December 2010 linked with a Vital Records birth certificate.

This figure presents the results from a quantile treatment effects model using methods from Bitler et al. (2006). The WIC participants are compared, by quantile, to a matched comparison group of nonparticipants. The matched comparison group was constructed with inverse probability weighting, as described in Chapter IV. The propensity score model included the full set of covariates shown in Table IV.4. The 95 percent confidence intervals are based on 500 bootstrapped iterations. An estimate greater than zero indicates that WIC participants (at a specific quantile) had higher costs than the matched comparison group of nonparticipants, and a negative association indicates WIC participants had lower costs than nonparticipants (at the same quantile). The outcome measure is defined in Table IV.3.

The analysis of Medicaid costs includes only fee-for-service recipients. Approximately 68 percent of Medicaid recipients in Missouri are enrolled in Medicaid managed care. Managed care claims in Missouri do not include information about actual costs of services.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Figure H.OK.1. Estimates of the association between any child WIC participation and total Medicaid costs in Oklahoma, by age cohort and quantile



Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Oklahoma continuously enrolled from January to December 2010 linked with a Vital Records birth certificate.

This figure presents the results from a quantile treatment effects model using methods from Bitler et al. (2006). The WIC participants are compared, by quantile, to a matched comparison group of nonparticipants. The matched comparison group was constructed with inverse probability weighting, as described in Chapter III. The propensity score model included the full set of covariates shown in Table IV.4. The 95 percent confidence intervals are based on 500 bootstrapped iterations. An estimate greater than zero indicates that WIC participants (at a specific quantile) had higher costs than the matched comparison group of nonparticipants, and a negative association indicates WIC participants had lower costs than nonparticipants (at the same quantile). The outcome measure is defined in Table IV.3.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table H.MO.2. Demographic and socioeconomic characteristics and health risk factors of Medicaid beneficiaries in Missouri, by managed care or fee-for-service enrollment and age cohort

	Cohort of 1-year-olds		Cohort of 2-year-olds		Cohort of 3-year-olds		Cohort of 4-year-olds	
	Fee-for-service	Managed care	Fee-for-service	Managed care	Fee-for-service	Managed care	Fee-for-service	Managed care
Mother's characteristics								
Age								
17 years or younger	6.1	6.2†	6.4	6.6	6.1	6.4†	6.5	7.2††
18 or 19 years	14.2	13.3	14.3	13.7	14.2	13.8	14.5	12.9
20–34 years	74.8	75.0	74.3	74.1	75.1	74.5	73.8	74.7
35 years or older	5.0	5.6	4.9	5.5	4.6	5.4	5.1	5.2
Race/ethnicity								
Hispanic	7.0	7.2††	6.5	7.2††	6.5	7.2††	5.9	7.1††
Non-Hispanic white	83.7	55.6	83.8	54.5	84.1	54.9	84.4	55.3
Non-Hispanic black	6.8	34.6	7.7	36.1	7.8	35.4	8.1	35.5
Non-Hispanic American Indian Alaskan Native	0.9	0.4	0.8	0.5	0.7	0.5	0.5	0.5
Non-Hispanic Asian Pacific Islander	1.1	1.6	0.9	1.4	0.8	1.4	0.8	1.2
Multiple races, other race, or unknown	0.3	0.5	0.2	0.4	0.2	0.5	0.3	0.5
Married	42.1	27.7**	41.5	28.1**	42.4	29.5**	43.8	29.9**
Education								
Less than high school	32.3	29.8††	33.2	31.6††	34.2	32.5††	34.7	34.0††
High school grad or GED	42.9	42.5	44.2	41.7	43.9	42.1	44.4	41.9
Some college, no degree	18.1	21.3	16.7	20.4	16.9	20.1	15.9	19.0
College degree	5.1	5.0	4.5	4.8	4.0	3.8	4.0	3.6
Unknown	1.6	1.4	1.3	1.5	0.9	1.5	0.9	1.6
Smoked during pregnancy	33.3	26.2**	34.0	26.7**	35.2	27.9**	36.2	28.4**
Any previous live births	63.5	61.8**	64.0	62.8*	63.4	63.6	63.6	63.0
Short inter-pregnancy interval	29.3	26.6**	29.1	27.4*	29.5	26.8**	29.2	26.6*
Child's characteristics								
Gender is male	51.3	51.9	52.1	51.1	52.1	51.4	50.8	50.7
Gestational age (in weeks)	38.5	38.3**	38.5	38.3**	38.5	38.4**	38.5	38.3**
Preterm birth (< 37 weeks)	11.5	10.9	11.2	10.8	10.6	11.1	11.7	11.4

	Cohort of 1-year-olds		Cohort of 2-year-olds		Cohort of 3-year-olds		Cohort of 4-year-olds	
	Fee-for-service	Managed care	Fee-for-service	Managed care	Fee-for-service	Managed care	Fee-for-service	Managed care
Very preterm birth (<= 32 weeks)	2.3	2.1	2.1	2.0	2.0	2.1	2.4	2.3
Birth weight (g)	3,205	3,201	3,202	3,209	3,203	3,214	3,195	3,209
Low birth weight (< 2,500g)	10.0	9.5	8.9	9.6	8.9	9.4	9.5	10.0
Very low birth weight (< 1,500g)	1.7	1.3**	1.5	1.3	1.5	1.3	1.4	1.4
Multiple birth	3.2	3.3	2.8	2.9	2.4	3.1**	3.3	3.4
Rural residence	61.0	24.4**	61.8	24.5**	60.6	25.4**	62.3	25.6**
Mean household income (as percentage of FPL)	36.1	41.0**	44.5	49.9**	45.2	50.2**	46.6	50.9**
Family income <= 100 percent of FPL	83.8	85.5**	80.2	82.5**	80.8	82.1**	79.8	81.8**
SNAP enrollment	84.4	86.3**	85.5	88.1**	85.4	88.2**	84.0	87.8**
TANF enrollment	27.1	32.0**	25.7	30.5**	24.0	28.1**	21.5	25.4**
Aged, blind, and/or disabled Medicaid enrollment category	0.9	0.2**	1.6	0.1**	1.9	0.1**	1.8	0.1**
Child Welfare Medicaid enrollment category	1.5	1.1**	1.5	0.9**	1.5	1.1**	1.3	1.0**
Sample size	**9,292**	**20,599**	**9,004**	**19,461**	**8,599**	**18,433**	**8,029**	**16,781**

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Missouri continuously enrolled from January to December 2010 linked with a Vital Records birth certificate.

The table presents the percentage of observations (for binary and categorical variables) and means (for continuous variables) of characteristics of Medicaid beneficiaries with Medicaid managed care claims and beneficiaries with only fee-for-service claims. Variables are defined in Table IV.4. The Medicaid managed care columns includes children without any claims who live in Medicaid managed care counties. Asterisks denote statistically significant differences from Student's t-tests for dichotomous and continuous variables (* $p < 0.05$; ** $p < 0.01$), and daggers (†) denote statistically significant chi-squared tests for categorical variables († $p < 0.05$; †† $p < 0.01$). Percentages across categories may not total 100 percent because of rounding and missing data.

FPL = Federal poverty level; GED = general education development degree; SNAP = Supplemental Nutrition Assistance Program; TANF = Temporary Assistance for Needy Families; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table H.MO.3. Estimates of the association between any child WIC participation and the primary outcomes in Missouri, by managed care or fee-for-service enrollment and age cohort

Outcome	Age cohort	Medicaid enrollment	
		Fee-for-service enrollment (included in analyses of Medicaid costs) (1)	Managed care (excluded from analyses of Medicaid costs) (2)
Primary outcomes			
Any well-child visits	1-year-olds	18.92** (1.25)	14.00** (0.74)
	2-year-olds	28.25** (1.50)	11.73** (0.84)
	3-year-olds	22.96** (1.59)	14.32** (0.89)
	4-year-olds	22.07** (1.62)	12.30** (0.93)
Any emergency room visits	1-year-olds	4.03** (1.20)	4.34** (0.78)
	2-year-olds	0.43 (1.37)	5.51** (0.86)
	3-year-olds	-1.60 (1.46)	5.15** (0.88)
	4-year-olds	1.63 (1.27)	5.59** (0.89)
Any visit for the diagnosis and treatment of a common childhood illness (%)[a]	1-year-olds	7.82** (1.02)	5.94** (0.63)
	2-year-olds	6.56** (1.27)	8.78** (0.80)
	3-year-olds	5.94** (1.45)	7.87** (0.86)
	4-year-olds	8.54** (1.53)	7.65** (0.92)
Secondary health care utilization outcomes			
Any visits with an immunization (CHIPRA code list)	1-year-olds	5.69** (1.30)	6.86** (0.71)
	2-year-olds	2.57 (1.39)	3.30** (0.86)
	3-year-olds	2.22 (1.41)	4.14** (0.86)
	4-year-olds	4.50** (1.47)	2.67** (0.93)

Outcome	Age cohort	Medicaid enrollment: Fee-for-service enrollment (included in analyses of Medicaid costs) (1)	Medicaid enrollment: Managed care (excluded from analyses of Medicaid costs) (2)
EPSDT visit	1-year-olds	11.95** (0.95)	8.37** (0.52)
	2-year-olds	18.09** (1.35)	10.25** (0.73)
	3-year-olds	14.88** (1.43)	12.30** (0.82)
	4-year-olds	14.64** (1.44)	11.73** (0.86)
Any hospitalizations	1-year-olds	0.16 (0.64)	0.73* (0.31)
	2-year-olds	1.36* (0.53)	0.72* (0.29)
	3-year-olds	0.34 (0.51)	-0.30 (0.28)
	4-year-olds	0.87 (0.50)	0.40 (0.24)
Any dental care visits (comprehensive code list)	1-year-olds	2.69** (0.64)	2.31** (0.38)
	2-year-olds	1.54** (0.52)	0.55* (0.27)
	3-year-olds	0.60 (0.71)	0.88** (0.27)
	4-year-olds	0.09 (0.86)	1.34** (0.31)
Sample size		**34,924**	**75,274**

Source: WM-II database for Missouri, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Missouri continuously enrolled from January to December 2010 linked with a Vital Records birth certificate.

Each column presents the difference in outcomes between Medicaid beneficiaries with Medicaid managed care claims and beneficiaries with only fee-for-service claims.

Robust standard errors are in parentheses. Asterisks indicate statistically significant differences between WIC participants and nonparticipants at the $p < .01$ (**) and $p < .05$ (*) levels.

[a] Otitis media (ear infection), upper respiratory infection, lower respiratory infection, asthma, iron deficiency anemia, gastroenteritis, or allergies.

CHIPRA = Children's Health Insurance Program Reauthorization Act; EPSDT = Early Periodic Screening, Diagnosis, and Treatment; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

Table H.OK.4. Demographic and socioeconomic characteristics and health risk factors of Native American and other Medicaid beneficiaries in Oklahoma

	Cohort of 1-year-olds		Cohort of 2-year-olds		Cohort of 3-year-olds		Cohort of 4-year-olds	
	Other race	Native American	Other race	Native American	Other race	Native American	Other race	Native American
Mother's characteristics								
Age								
17 years or younger	5.7	6.5††	6.2	7.1††	6.5	6.8††	6.3	8.1††
18 or 19 years	12.8	14.8	13.0	14.8	12.7	14.4	12.6	14.3
20–34 years	75.8	75.0	75.1	74.4	75.3	74.4	75.5	73.5
35 years or older	5.7	3.7	5.7	3.7	5.5	4.4	5.6	4.1
Unknown	0.0	0.0			0.0	0.0		
Race/ethnicity								
Hispanic	21.7	4.5††	20.9	4.0††	21.3	3.5††	20.5	3.1††
Non-Hispanic white	58.1	30.7	58.9	31.2	58.3	33.5	58.5	34.0
Non-Hispanic black	14.7	2.3	15.0	2.2	15.3	2.6	16.0	2.5
Non-Hispanic American Indian or Alaskan Native	3.1	60.2	3.4	62.1	3.3	59.7	3.0	59.8
Non-Hispanic Asian Pacific Islander	1.7	0.4	1.6	0.3	1.4	0.3	1.4	0.2
Multiple races, other race, or unknown	0.8	2.0	0.2	0.2	0.4	0.3	0.5	0.4
Married	40.8	36.9**	41.6	37.8**	41.9	38.0**	43.0	40.3**
Education								
Less than high school	32.6	30.3††	33.1	31.2††	34.9	31.9††	34.9	32.7††
High school grad or GED	42.8	45.5	44.0	47.6	43.7	48.4	43.4	46.3
Some college, no degree	18.9	19.8	17.6	17.0	16.2	16.3	16.8	17.2
College degree	5.2	3.9	4.7	3.9	4.5	3.0	4.4	3.5
Unknown	0.5	0.5	0.6	0.3	0.7	0.4	0.6	0.3
Smoked during pregnancy	19.8	20.3	21.7	20.8	22.3	23.0	22.2	21.6
Any previous live births	63.2	62.9	64.0	63.3	64.9	64.4	64.1	64.1
Short inter-pregnancy interval	22.5	24.5**	23.7	25.3*	22.8	24.4	21.9	24.4**
Child's characteristics								
Gender is male	51.6	51.6	50.9	52.2	51.6	50.8	51.7	50.6

	Cohort of 1-year-olds		Cohort of 2-year-olds		Cohort of 3-year-olds		Cohort of 4-year-olds	
	Other race	Native American	Other race	Native American	Other race	Native American	Other race	Native American
Gestational age (in weeks)	38.3	38.3	38.4	38.4	38.4	38.4	38.5	38.5
Preterm birth (< 37 weeks)	11.5	10.9	11.2	10.8	10.8	11.2	11.0	9.7*
Very preterm birth (<= 32 weeks)	2.2	1.8	2.2	1.9	2.2	2.0	2.0	1.7
Birth weight (g)	3,281	3,195**	3,276	3,193**	3,289	3,203**	3,305	3,217**
Low birth weight (< 2,500g)	9.8	7.8**	9.2	7.5**	9.1	7.6**	9.0	6.3**
Very low birth weight (< 1,500g)	1.5	0.9**	1.4	1.0*	1.2	1.1	1.3	1.2
Multiple birth	3.0	2.4*	3.0	2.9	2.9	1.8**	2.8	1.9**
Rural residence	36.3	66.0**	36.9	67.4**	36.2	67.7**	36.2	66.3**
Mean household income (as percentage of FPL)	51.5	53.7**	50.4	56.2**	51.8	57.2**	54.0	57.8**
Family income <=100 percent of FPL	80.7	80.9	79.7	81.9**	79.2	81.8**	79.1	79.9
TANF enrollment	99.1	99.2	98.6	99.3**	98.2	99.0**	98.0	98.2
Aged, blind, and/or disabled Medicaid enrollment category	0.5	0.1**	0.6	0.4	0.6	0.3	0.8	0.7
Child Welfare Medicaid enrollment category	3.3	4.8**	3.6	5.4**	3.4	5.6**	3.5	4.9**
Sample size	**17,291**	**4,058**	**15,974**	**3,761**	**15,780**	**3,652**	**14,252**	**3,366**

Source: WM-II database for Oklahoma, constructed by Mathematica Policy Research.

Notes: Based on Medicaid beneficiaries in Oklahoma continuously enrolled from January to December 2010 linked with a Vital Records birth certificate.

The table presents the percentage of observations for binary and categorical variables, and presents means for continuous variables. Variables are defined in Table IV.4. Asterisks denote statistically significant differences between WIC participants and nonparticipants from Student's t-tests for dichotomous and continuous variables (* $p < 0.05$; ** $p < 0.01$), and daggers (†) denote statistically significant chi-squared tests for categorical variables († $p < 0.05$; †† $p < 0.01$). Percentages across categories might not total 100 percent because of rounding and missing data. See Appendix C for comparisons of WIC participants and nonparticipants after inverse probability weighting.

FPL = Federal poverty level; GED = general education development degree; TANF = Temporary Assistance for Needy Families; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; WM-II = WIC-Medicaid II Feasibility Study.

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