SUPPLEMENTAL MATERIALS

DIFFERENCE-IN-DIFFERENCES ANALYSIS

In the main analysis, the difference-in-differences (DID) models included an interaction term between a binary variable for whether a woman had received WIC during pregnancy and a binary variable for whether she gave birth before or after the relevant WIC revision date for her state of residence. The equation for this model for a given outcome *Y* was specified as follows, for a given infant *i* born to mother *m* in year *t* in state *s*:

$$Y_{imts} = \beta_1 WIC_{imts} \times Post_{ts} + \beta_2 WIC_{imts} + \beta_3 Post_{ts} + \beta_4 Covar_{imts} + \beta_5 State_s + \beta_6 Year_t + \varepsilon_{imts}$$

The coefficient of interest, β_1, represents the effect of the revised WIC program on the outcome of interest. *Covar* is a vector of covariates representing maternal and child characteristics, *State* represents state fixed effects, and *Year* represents year fixed effects. Including state fixed effects in models accounts for time-invariant observed and unobserved characteristics of states that might affect both timing of WIC revision implementation and the health outcomes of interest.[1] ε represents robust standard errors clustered by a woman's state of residence. Both continuous and binary outcomes were modeled using linear models. This is standard for DID analyses because of the different interpretation of interaction terms in non-linear models.[2] Coefficients for binary outcomes can therefore be interpreted as the percentage point change in risk.

DID analysis requires that several assumptions be met. First, this method assumes that pre/post differences in outcomes would have been similar between WIC recipients and non-recipients in

the absence of the revised WIC program. While we cannot directly test this counterfactual scenario, we assessed whether the trends in outcomes during the pre-revision period were parallel for WIC recipients and non-recipients by graphing trends separately for these two groups (eFigure 1, eFigure 2). Additionally, we assessed the parallel trends assumption quantitatively (eTable 2). To do so, we regressed each outcome on an interaction term between the binary variable for WIC receipt during pregnancy and a continuous variable representing the time difference between birth date and relevant WIC revision date (in months). A null result for the coefficient on this interaction term would suggest the parallel trends assumption may not be violated during the pre-revision period.

Second, DID assumes any observed effects are not due to differential compositional changes among WIC recipients and non-recipients over time. We therefore compared whether the pre/post changes in observed covariates were similar among WIC recipients and non-recipients to rule out differential compositional changes over time (e.g., due to changes in the population receiving WIC during the Great Recession) (Table 1). For most covariates, pre/post changes among WIC recipients were similar to those among non-recipients. While we are unable to test whether there are differences in unobserved characteristics, we adjust for the observed characteristics to account for possible confounding.

MULTIPLE IMPUTATION

We conducted multiple imputation using chained equations.[3] We assume that the data are missing at random rather than missing completely at random.[4] All variables used in the analytic

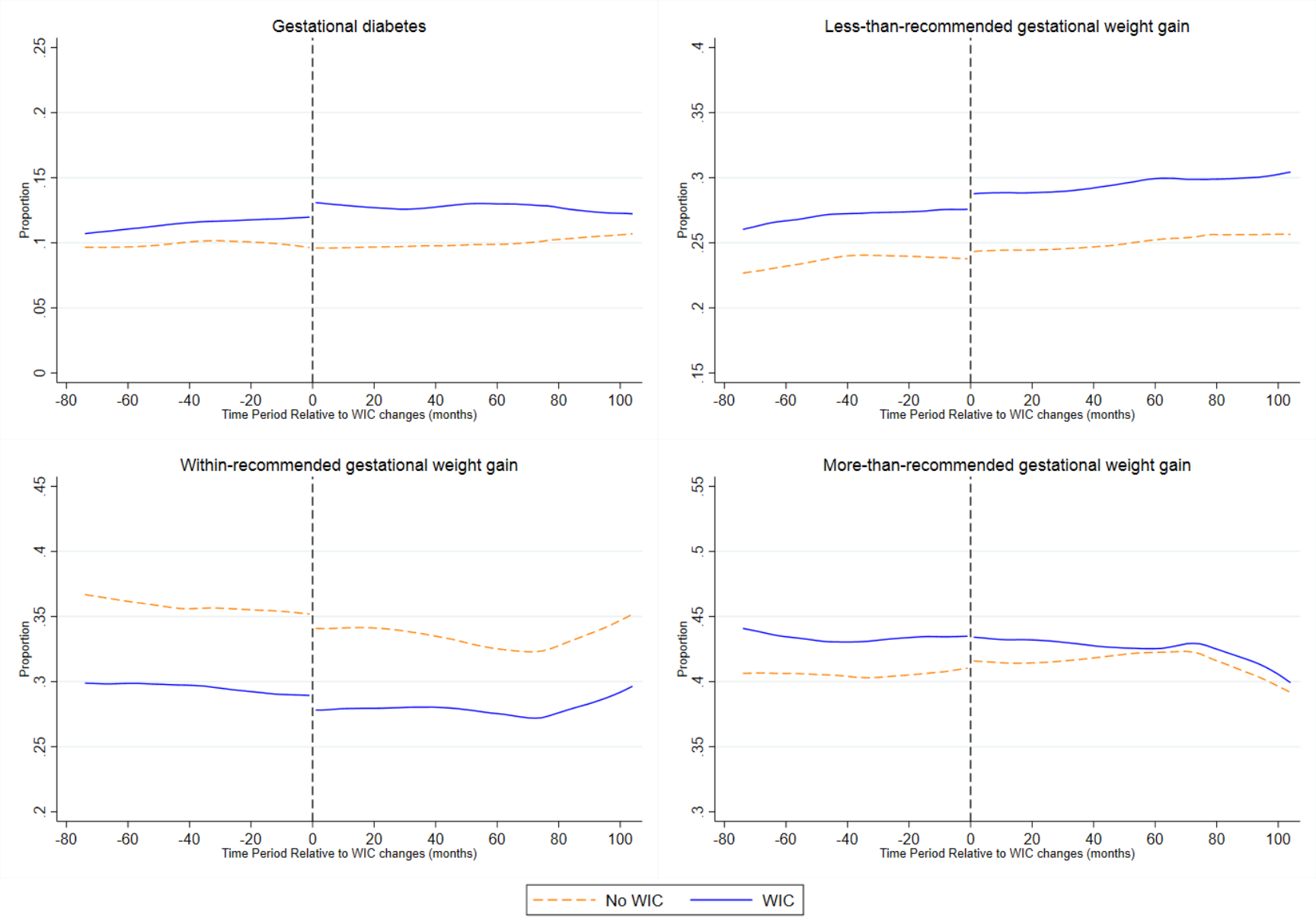
models are included in the imputation models, including outcome variables, in order to improve the prediction of missing covariates. We do not use imputed values of the outcome variables in the analyses, however, as this is likely to add noise to subsequent estimates.[5] We produce 50 imputations, which is a sufficient number to reduce sampling variability from the imputation process.[6]

SENSITIVITY ANALYSIS: PROPENSITY SCORE MATCHING

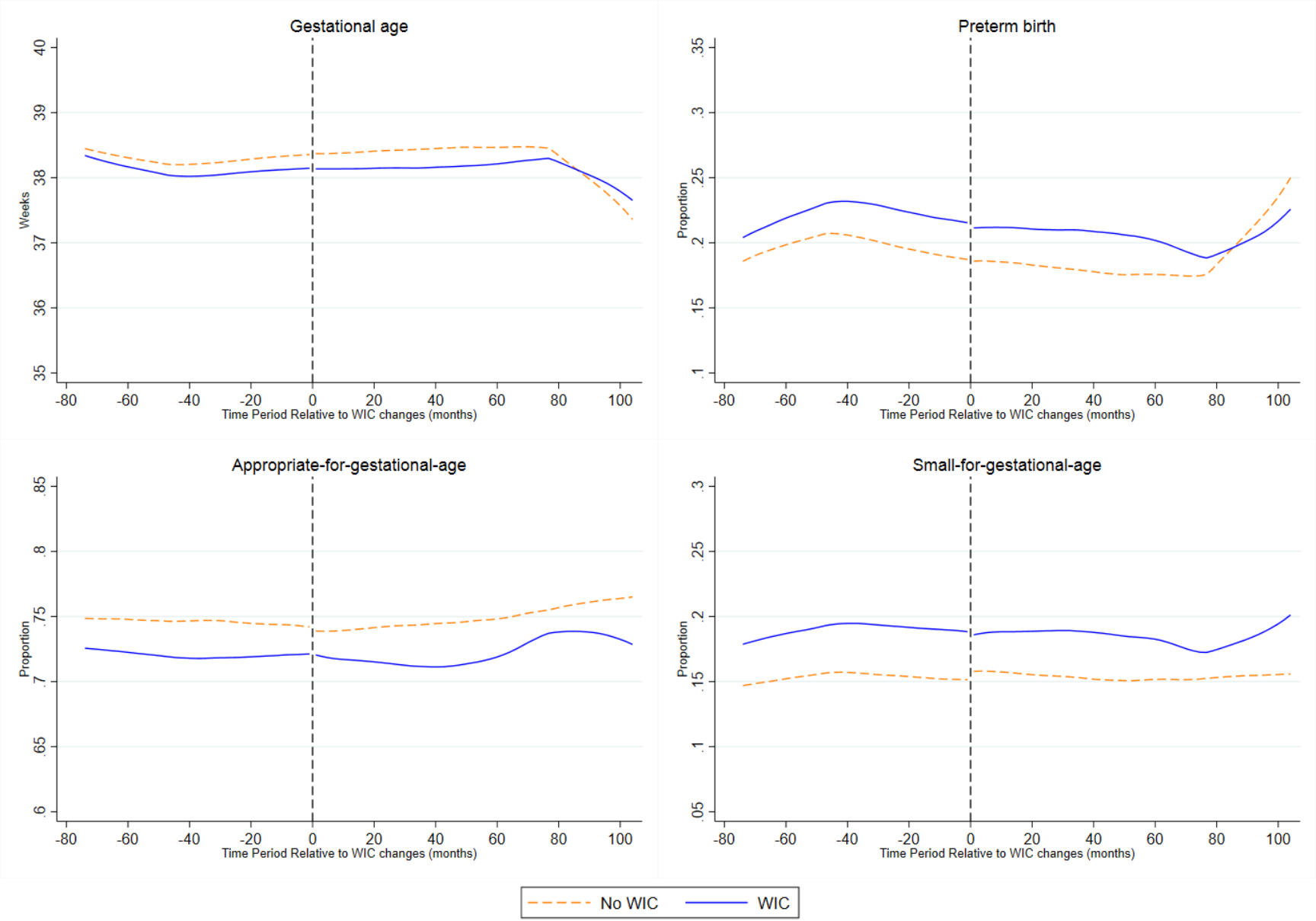
We conducted an additional sensitivity analysis using propensity score matching to try to identify a stronger comparison group within our sample. We used logistic regression with WIC receipt as the outcome to identify participants who did not receive WIC but returned a propensity score greater than 0.5 (indicating that they were similar to WIC participants in terms of their observed characteristics). These logistic regression models were adjusted for the same set of covariates as the main analyses. The sample size for this new comparison group of WIC non-recipients was 27,866, and the treatment group of WIC recipients from the main analysis remained at 161,073, so the total number of observations was 188,939.

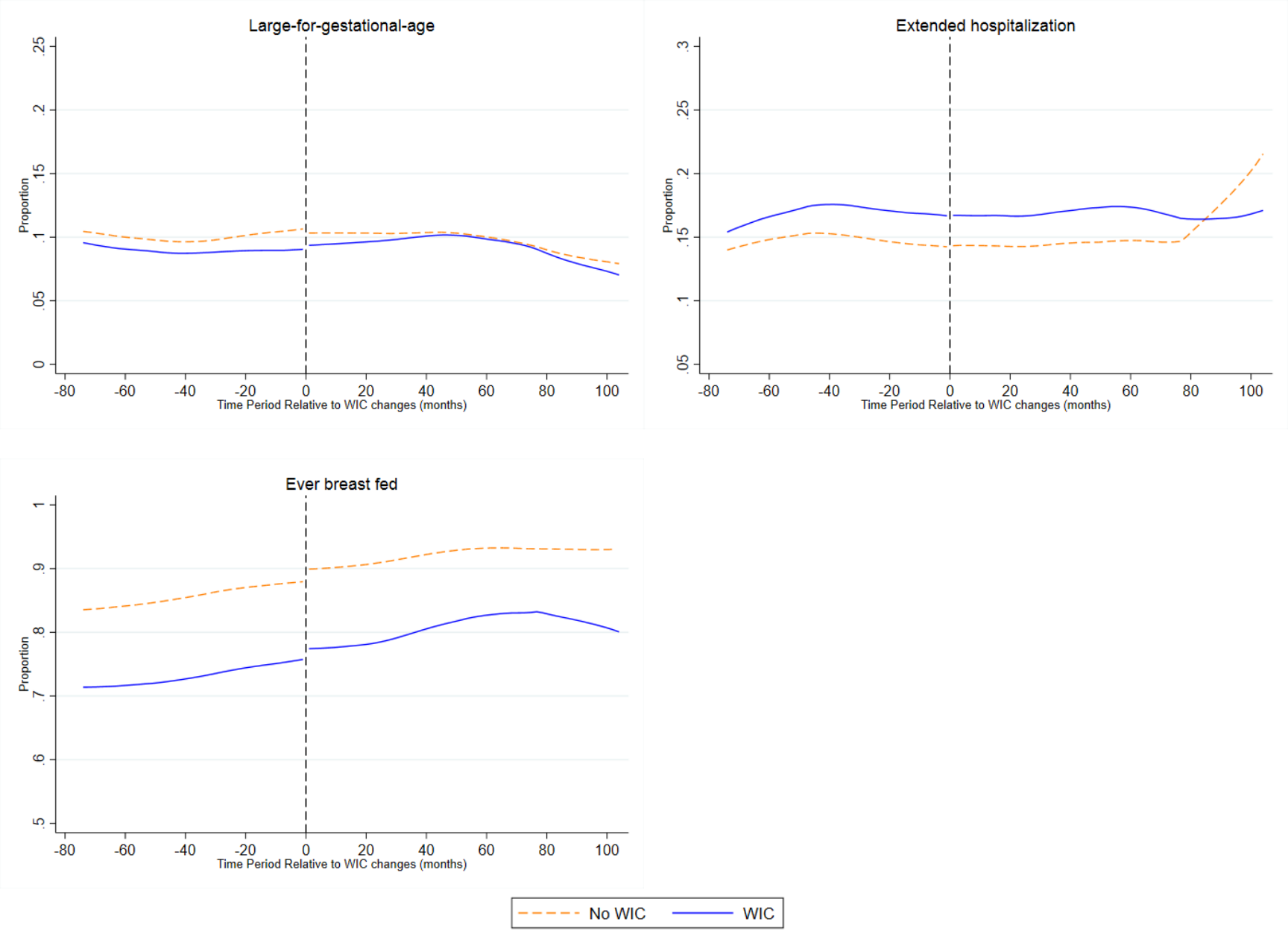
When we examined the parallel trends for this sensitivity analysis that used propensity score matching, the trends during the pre-revision period were no longer parallel among WIC recipients and non-recipients, including for many of the outcomes that had been parallel in our main analysis. Therefore, we do not present the results from this sensitivity analysis here.

eFigure 1. Graphs of Trends for Maternal Health Outcomes



eFigure 2. Graphs of Trends for Infant Health Outcomes




Large-for-gestational-age
Proportion
0
.05
.1
.15
.2
.25
-80
-60
-40
-20
0
20
40
60
80
100
Time Period Relative to WIC changes (months)
Extended hospitalization
Proportion
.05
.1
.15
.2
.25
.3
-80
-60
-40
-20
0
20
40
60
80
100
Time Period Relative to WIC changes (months)
Ever breast fed
Proportion
.5
.6
.7
.8
.9
1
-80
-60
-40
-20
0
20
40
60
80
100
Time Period Relative to WIC changes (months)
No WIC
WIC

eTable 1. Number of Respondents by State and Year, Pregnancy Risk Assessment Monitoring System

	Year *(No.)*														
State	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Total**
Alaska	1,239	1,271	1,316	1,385	1,217	1,134	1,045	0	837	1,241	1,135	1,173	1,107	984	**15,084**
Arkansas	1,930	2,071	1,931	1,726	1,526	1,110	1,431	1,233	751	971	0	848	815	0	**16,343**
Colorado	1,823	1,855	1,879	1,909	1,886	1,832	1,803	1,719	1,149	1,550	0	1,615	1,525	1,100	**21,645**
Delaware [a]	0	0	0	655	1,177	1,036	1,037	999	972	957	890	878	870	823	**10,294**
Georgia	1,446	1,625	1,884	679	917	787	1,064	1,499	1,057	723	0	0	0	900	**12,581**
Hawaii	1,960	1,597	1,538	1,619	1,637	1,473	1,426	1,447	1,375	1,365	1,195	1,194	1,007	0	**18,833**
Illinois	1,814	1,563	1,589	1,622	1,568	1,458	1,453	1,380	1,014	1,301	1,337	1,425	1,240	1,112	**19,876**
Maine	1,039	1,064	1,076	1,048	1,036	985	981	939	609	866	843	776	747	804	**12,813**
Maryland	1,443	1,234	1,491	1,483	1,523	1,412	1,357	1,337	856	1,212	1,240	1,200	1,079	975	**17,842**
Massachusetts [a]	0	0	0	1,421	1,426	1,304	1,455	1,543	1,475	1,426	1,494	1,283	1,265	1,369	**15,461**
Michigan	1,242	1,234	1,079	1,434	1,509	1,548	1,307	1,537	1,874	1,911	0	1,503	1,675	1,773	**19,626**
Missouri [a]	0	0	0	1,285	0	1,258	1,436	1,141	771	1,107	1,077	1,041	970	1,017	**11,103**
Nebraska	1,669	1,811	1,629	1,539	1,511	1,761	1,757	1,673	1,107	1,566	1,395	1,353	1,258	0	**20,029**
New Jersey	2,176	2,156	1,925	1,526	1,444	1,402	1,366	1,346	1,021	907	1,293	1,134	1,273	1,222	**20,191**
New York [b]	1,646	2,020	1,938	2,349	0	0	2,218	2,261	0	2,394	2,069	2,261	2,210	1,995	**23,361**
Oklahoma	1,710	1,726	1,785	1,885	1,812	1,897	1,778	1,779	1,666	1,733	1,678	1,797	1,749	1,544	**24,539**
Oregon	1,810	1,785	1,815	1,763	1,548	1,591	1,711	1,686	737	1,481	0	1,406	0	0	**17,333**
Pennsylvania [a]	0	0	0	629	1,044	993	957	1,009	740	1,012	1,058	1,038	982	1,146	**10,608**
Rhode Island	1,363	1,253	1,214	1,252	1,158	1,164	1,151	1,151	1,119	1,074	1,144	0	1,065	1,016	**15,124**
Utah	1,841	1,801	1,876	1,683	1,675	1,571	1,472	1,356	1,493	1,343	1,322	1,293	1,292	1,331	**21,349**
Washington	1,423	1,327	1,464	1,396	1,486	1,508	1,508	1,143	974	1,033	1,140	1,169	1,197	1,156	**17,924**
West Virginia	800	1,531	1,607	1,614	1,558	1,497	1,323	1,474	1,068	1,310	1,180	1,104	736	651	**17,453**
Wisconsin [a]	0	0	0	980	963	941	0	1,517	1,468	1,478	1,432	1,404	1,181	1,276	**12,640**
Wyoming [a]	0	0	0	883	880	868	923	644	604	585	594	534	581	480	**7,576**

[a] State not included in main analysis sample.

[b] Although administered separately, responses for New York State and New York City were aggregated into one group.

eTable 2. Quantitative Assessment for Parallel Trends During the Pre-Revision Period

Characteristic	β[a]	95% CI
Panel A. Maternal Outcomes		
Gestational diabetes	0.00017	(-0.000022, 0.00036)
Gestational weight gain[b]		
Less than recommended	0.000027	(-0.00024, 0.00029)
Within recommended range	0.00011	(-0.00023, 0.00044)
More than recommended	-0.00013	(-0.00053, 0.00026)
Panel B. Infant Outcomes		
Gestational age	-0.0015	(-0.0031, 0.00014)
Preterm birth	0.00014	(-0.000071, 0.00036)
Fetal growth		
AGA	0.000031	(-0.00030, 0.00036)
SGA	0.000092	(-0.00014, 0.00033)
LGA	-0.00012	(-0.00038, 0.00013)
Extended hospitalization	0.000097	(-0.000065, 0.00026)
Ever breast feeding	0.000035	(-0.00023, 0.00030)

Abbreviations: WIC, Special Supplemental Nutrition Program for Women, Infants, and Children; AGA, Appropriate for gestational age; SGA, Small for gestational age; LGA, Large for gestational age

[a] β represents the coefficient from the interaction term between the binary variable for WIC receipt during pregnancy and a continuous variable representing the time difference between birth date and relevant WIC revision date (in months) during the pre-revision period. A null finding suggests that trends were not quantitatively non-parallel during the pre-revision period.

[b] Gestational weight gain categories are based on 1990 recommendations of the Institute of Medicine.

eTable 3A. Association of Revised WIC Program with Maternal and Infant Outcomes, by Age[a]

	Association of Revised WIC Program (95% CI) by Age			
Outcome	**<25 (Reference)**	**25-29**	**30-34**	**35+**
Panel A. Maternal Outcomes				
Gestational weight gain[b]				
Less than recommended	-0.21 (-1.69, 1.27)	0.87 (-0.36, 2.11)	0.88 (-1.07, 2.82)	0.50 (-1.70, 2.71)
Within recommended range	-0.50 (-1.75, 0.76)	0.69 (-0.69, 2.07)	0.96 (-0.72, 2.64)	4.10 (1.77, 6.42)
More than recommended	0.71 (-0.98, 2.40)	-1.56 (-2.75, -0.38)	-1.83 (-3.37, -0.29)	-4.60 (-6.82, -2.38)
Panel B. Infant Outcomes				
Gestational age (weeks)	-0.06 (-0.20, 0.07)	-0.02 (-0.12, 0.08)	0.11 (-0.02, 0.23)	-0.04 (-0.18, 0.10)
Preterm birth	0.52 (-1.03, 2.08)	-0.69 (-2.05, 0.67)	-0.68 (-1.68, 0.32)	-0.98 (-3.69, 1.73)
Fetal growth				
AGA	0.55 (-0.72, 1.82)	-0.08 (-1.14, 0.99)	0.53 (-0.86, 1.91)	1.05 (-1.05, 3.15)
SGA	-0.54 (-2.13, 1.05)	-0.02 (-0.77, 0.73)	-1.20 (-2.33, -0.07)	-1.30 (-2.76, 0.16)
Extended Hospitalization	0.57 (-0.99, 2.12)	-0.83 (-2.18, 0.51)	-0.49 (-1.70, 0.72)	-0.18 (-1.67, 1.30)
Ever breast feeding	0.74 (-0.77, 2.26)	1.16 (-0.15, 2.46)	0.15 (-1.20, 1.50)	0.90 (-0.65, 2.44)

Abbreviations: WIC, Special Supplemental Nutrition Program for Women, Infants, and Children; AGA, Appropriate for gestational age; SGA, Small for gestational age; LGA, Large for gestational age

[a] Values in table represent the coefficients on the interaction term between WIC receipt and post-revision time period in analyses stratified by age. Coefficients for binary outcomes were multiplied by 100 and therefore represent a change in percentage points. Analysis involved multivariable linear models (i.e. linear probability models for binary outcomes) with maternal fixed effects and robust standard errors clustered by state of residence. Covariates included year, age, race/ethnicity, years of education, marital status, household income in 12 months prior to delivery, receipt of Medicaid during pregnancy, and parity. Results are multiple-imputation estimates from 50 imputations of missing covariates.

[b] Gestational weight gain categories are based on 1990 recommendations of the Institute of Medicine.

eTable 3B. Association of Revised WIC Program with Maternal and Infant Outcomes, by Education[a]

	Association of Revised WIC Program (95% CI) by Education		
Outcome	**< 12 Years (Reference)**	**= 12 Years**	**> 12 Years**
Panel A. Maternal Outcomes			
Gestational weight gain[b]			
Less than recommended	-1.32 (-3.75, 1.11)	0.74 (-0.78, 2.25)	0.31 (-0.81, 1.43)
Within recommended range	1.11 (-1.44, 3.66)	-0.02 (-1.84, 1.80)	1.17 (0.21, 2.14)
More than recommended	0.21 (-2.68, 3.11)	-0.72 (-2.44, 1.00)	-1.48 (-2.60, -0.37)
Panel B. Infant Outcomes			
Gestational age (weeks)	0.14 (-0.04, 0.32)	0.02 (-0.07, 0.11)	0.00 (-0.09, 0.09)
Preterm birth	0.19 (-1.87, 2.24)	-1.31 (-2.25, -0.37)	-0.82 (-1.94, 0.30)
Fetal growth			
AGA	0.10 (-1.95, 2.15)	0.36 (-1.21, 1.94)	0.29 (-0.61, 1.19)
SGA	-0.77 (-2.65, 1.11)	-0.92 (-2.33, 0.49)	-0.73 (-1.64, 0.19)
Extended Hospitalization	-0.38 (-1.78, 1.01)	-0.63 (-1.68, 0.41)	-0.44 (-1.50, 0.61)
Ever breast feeding	-1.65 (-4.58, 1.28)	-0.01 (-1.74, 1.72)	0.94 (0.00, 1.88)

Abbreviations: WIC, Special Supplemental Nutrition Program for Women, Infants, and Children; AGA, Appropriate for gestational age; SGA, Small for gestational age; LGA, Large for gestational age

[a] Values in table represent the coefficients on the interaction term between WIC receipt and post-revision time period in analyses stratified by education. Coefficients for binary outcomes were multiplied by 100 and therefore represent a change in percentage points. Analysis involved multivariable linear models (i.e. linear probability models for binary outcomes) with maternal fixed effects and robust standard errors clustered by state of residence. Covariates included year, age, race/ethnicity, years of education, marital status, household income in 12 months prior to delivery, receipt of Medicaid during pregnancy, and parity. Results are multiple-imputation estimates from 50 imputations of missing covariates.

[b] Gestational weight gain categories are based on 1990 recommendations of the Institute of Medicine.

eTable 3C. Association of Revised WIC Program with Maternal and Infant Outcomes, by Race and Ethnicity[a]

	Association of Revised WIC Program (95% CI) by Race and Ethnicity				
Outcome	**White (Reference)**	**Black**	**Asian**	**Hispanic/Latina**	**Other**
Panel A. Maternal Outcomes					
Gestational weight gain[b]					
Less than recommended	1.33 (0.02, 2.63)	-0.66 (-2.66, 1.34)	2.72 (-0.59, 6.03)	-0.41 (-2.58, 1.75)	2.30 (-0.93, 5.53)
Within recommended range	0.31 (-1.05, 1.67)	0.97 (-1.04, 2.98)	2.37 (-1.04, 5.78)	1.31 (-0.93, 3.55)	-1.05 (-3.08, 0.97)
More than recommended	-1.64 (-2.73, -0.54)	-0.31 (-2.77, 2.15)	-5.10 (-8.55, -1.64)	-0.90 (-3.51, 1.72)	-1.25 (-4.76, 2.26)
Panel B. Infant Outcomes					
Gestational age (weeks)	-0.08 (-0.21, 0.05)	-0.02 (-0.23, 0.19)	-0.04 (-0.18, 0.09)	-0.02 (-0.16, 0.13)	0.01 (-0.20, 0.23)
Preterm birth	0.21 (-1.73, 2.14)	-0.32 (-2.35, 1.71)	0.57 (-1.30, 2.45)	0.44 (-1.56, 2.44)	-0.46 (-2.70, 1.77)
Fetal growth					
AGA	-1.05 (-2.76, 0.66)	0.09 (-2.41, 2.60)	-0.22 (-2.57, 2.14)	0.05 (-1.19, 1.28)	1.81 (-0.34, 3.96)
SGA	0.37 (-1.50, 2.24)	-0.82 (-2.71, 1.06)	-0.61 (-2.54, 1.32)	-0.65 (-1.85, 0.54)	-0.59 (-2.66, 1.48)
Extended Hospitalization	1.48 (-0.26, 3.23)	-0.29 (-2.46, 1.89)	0.99 (-0.61, 2.59)	-1.00 (-2.78, 0.79)	-0.38 (-3.18, 2.42)
Ever breast feeding	1.75 (0.38, 3.12)	1.27 (-0.24, 2.77)	1.06 (-0.42, 2.54)	-0.64 (-1.77, 0.48)	0.88 (-0.59, 2.35)

Abbreviations: WIC, Special Supplemental Nutrition Program for Women, Infants, and Children; AGA, Appropriate for gestational age; SGA, Small for gestational age; LGA, Large for gestational age

[a] Values in table represent the coefficients on the interaction term between WIC receipt and post-revision time period in analyses stratified by race and ethnicity. Coefficients for binary outcomes were multiplied by 100 and therefore represent a change in percentage points. Analysis involved multivariable linear models (i.e. linear probability models for binary outcomes) with maternal fixed effects and robust standard errors clustered by state of residence. Covariates included year, age, race/ethnicity, years of education, marital status, household income in 12 months prior to delivery, receipt of Medicaid during pregnancy, and parity. Results are multiple-imputation estimates from 50 imputations of missing covariates.

[b] Gestational weight gain categories are based on 1990 recommendations of the Institute of Medicine.

eTable 3D. Association of Revised WIC Program with Maternal and Infant Outcomes, by Marital Status[a]

	Association of Revised WIC Program (95% CI) by Marital Status	
Outcome	**Unmarried (Reference)**	**Married**
Panel A. Maternal Outcomes		
Gestational weight gain[b]		
Less than recommended	-0.76 (-2.44, 0.93)	1.35 (0.14, 2.57)
Within recommended range	0.63 (-0.73, 1.99)	0.82 (-0.42, 2.06)
More than recommended	0.13 (-1.37, 1.63)	-2.17 (-3.17, -1.17)
Panel B. Infant Outcomes		
Gestational age (weeks)	0.00 (-0.09, 0.10)	-0.01 (-0.10, 0.07)
Preterm birth	-0.22 (-1.38, 0.93)	-0.41 (-1.53, 0.71)
Fetal growth		
AGA	0.07 (-1.23, 1.37)	0.23 (-0.79, 1.25)
SGA	-0.25 (-1.66, 1.15)	-0.78 (-1.60, 0.04)
Extended Hospitalization	-0.21 (-1.43, 1.01)	-0.20 (-1.12, 0.72)
Ever breast feeding	-0.84 (-1.94, 0.25)	0.54 (-0.94, 2.02)

Abbreviations: WIC, Special Supplemental Nutrition Program for Women, Infants, and Children; AGA, Appropriate for gestational age; SGA, Small for gestational age; LGA, Large for gestational age

[a] Values in table represent the coefficients on the interaction term between WIC receipt and post-revision time period in analyses stratified by marital status. Coefficients for binary outcomes were multiplied by 100 and therefore represent a change in percentage points. Analysis involved multivariable linear models (i.e. linear probability models for binary outcomes) with maternal fixed effects and robust standard errors clustered by state of residence. Covariates included year, age, race/ethnicity, years of education, marital status, household income in 12 months prior to delivery, receipt of Medicaid during pregnancy, and parity. Results are multiple-imputation estimates from 50 imputations of missing covariates.

[b] Gestational weight gain categories are based on 1990 recommendations of the Institute of Medicine.

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