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Oregon's Expansion of Prenatal Care Improved Utilization Among Immigrant Women

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Abstract

Objectives To determine whether expanding Emergency Medicaid to cover prenatal care in Oregon affected maternal health outcomes for unauthorized immigrants. *Methods* This study takes place in Oregon from 2003 to 2015 and includes all Emergency Medicaid and Medicaid claims for women aged 12–51 with a pregnancy related claim. To isolate the effect of expanding access to prenatal care, we utilized a difference-in-differences approach that exploits the staggered rollout of the prenatal care program. The primary outcome was a composite measure of severe maternal morbidity and mortality. Additional outcomes include adequacy of prenatal care, detection of pregnancy complications and birth outcomes. *Results* A total of 213,746 pregnancies were included, with 35,182 covered by Emergency Medicaid, 12,510 covered by Emergency Medicaid Plus (with prenatal care), and 166,054 covered by standard Medicaid. Emergency Medicaid Plus coverage did not affect severe maternal morbidity (all pregnancies 0.05%, CI −0.29; 0.39; high-risk pregnancies 2.20%, CI −0.47; 4.88). The program did reduce inadequate care among all pregnancies (−31.75%, 95% CI −34.47; −29.02) and among high risk pregnancies (−38.60%, CI −44.17; −33.02) and increased diagnosis of gestational diabetes (6.24%, CI 4.36; 8.13; high risk pregnancies 10.48%, CI 5.87; 15.08), and poor fetal growth (7.37%, CI 5.69; 9.05; high risk pregnancies 5.34%, CI 1.00; 9.68). The program also increased diagnosis of pre-existing diabetes mellitus (all pregnancies 2.93%, CI 2.16; 3.69), hypertensive diseases of pregnancy (all pregnancies 1.28%, CI 0.52; 2.04) and a history of preterm birth (all pregnancies 0.87%, CI 0.27; 1.47). *Conclusions for Practice* Oregon's prenatal care expansion program produced positive effects for unauthorized immigrant women and their children.

Keywords Unauthorized immigrants · Emergency Medicaid · CHIP · Prenatal care · Oregon

Significance

What is already known on this subject? The majority of states (33) extend some prenatal care services to unauthorized immigrants otherwise excluded from traditional Medicaid. Previous studies showed increased uptake of care associated with the programs but no change in health outcomes.

What this study adds? Access to prenatal care did not change the risk of severe maternal morbidity but increased adequate prenatal care and detection of high risk pregnancy conditions for eligible women. A companion paper detailed improved uptake of preventive care and better health outcomes for those women's offspring. Oregon's prenatal care expansion program for Emergency Medicaid recipients had positive health effects for unauthorized immigrants and their children.

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Introduction

Prenatal care is recommended as an important component of a healthy pregnancy (AAA 2012; WHO Recommendations on Health Promotion Interventions for Maternal and Newborn Health 2015). Participation in prenatal care is thought not only to identify and avoid complications of pregnancy for the woman, but also to improve the health of her offspring (AAA 2012; WHO Recommendations on Health Promotion Interventions for Maternal and Newborn Health 2015). In addition to positive associations with health promotion, birth preparation, and detection of conditions that may complicate birth including anemia, hypertension and infection (AAA 2012; Carroli et al. 2001; Lu et al. 2000; Mbuagbaw et al. 2015), previous studies have demonstrated the harm of inadequate prenatal care. A lack of prenatal care has been associated with low birth weight, preterm birth and even neonatal death (Lu et al. 2000; Mbuagbaw et al. 2015; Vintzileos et al. 2002).

While prenatal care is thought to be an essential preventive service, access is not universal. In the United States (US), Medicaid is the largest payer for obstetric care, financing nearly half of all births (Markus et al. 2013). As the largest insurer for maternity care in the US, Medicaid policy has a significant impact on perinatal health outcomes (Dahlen et al. 2017; Iams et al. 2017; Johnson et al. 2015; Lu et al. 2000).

Federal law restricts immigrant participation in standard Medicaid. Authorized immigrants who have been in the US for < 5 years, and unauthorized immigrants are eligible for Emergency Medicaid coverage only (Derose et al. 2007). Individuals qualifying for Emergency Medicaid must meet the same financial eligibility criteria as standard Medicaid applicants, however Emergency Medicaid only covers life threatening conditions or an admission for childbirth, and excludes antenatal or postpartum care. For women with a pregnancy covered by Emergency Medicaid, coverage ends the day that they give birth. Their children, as US citizens, are eligible for standard Medicaid. Previous research has demonstrated that obstetrical diagnoses account for over 80% of Emergency Medicaid claims (California Health Care Foundation 2013; DuBard and Massing 2007; Swartz et al. 2015).

States have adopted differing strategies to provide expanded care for immigrant women during pregnancy. As of 2015, 33 states had used a combination of three provisions: state funding of services; federal matching dollars through the Children's Health Insurance Program (CHIP) enacted in 2002 as a means for covering the "unborn child," a future US citizen by birth; and federal matching dollars through the Children's Health Insurance Program Reauthorization Act (CHIPRA), enacted in 2009, which permits eligible legal permanent residents with < 5 years residence (Wherry et al. 2017). Two recent studies using birth certificate data compared immigrant women in states with prenatal coverage to those women in states without coverage found increased uptake of prenatal care, but no difference in birth outcomes (Drewry et al. 2015; Wherry et al. 2017). While these provide a preliminary look at the programs, their results are not definitive because they overlook heterogeneity between states and cannot reliably isolate the affected population.

Oregon provides an excellent case study for understanding the effects of expanded coverage for prenatal care, with a specific focus on unauthorized immigrants. In 2008, Oregon began a pilot program of expanded access to prenatal care for all recent and unauthorized immigrant women called Citizen/Alien Waived Emergent Medical Care Plus. In the following, we refer to this program as Emergency Medicaid Plus. Emergency Medicaid Plus began in two counties and expanded in a stepwise fashion to all 36 Oregon counties by 2013. The structured expansion created a natural experiment by which to compare immigrant women who had access to prenatal care to those women who remained without access. Eligibility was determined by county of residence and therefore not subject to self-selection.

In this study, we use a difference-in-differences framework to evaluate the effects of access to prenatal care for immigrant women. We previously evaluated the effect of prenatal care utilization on maternal utilization of services and infant outcomes. We found that infants born to women with access to prenatal care had markedly improved health outcomes, including: increased utilization of well-child care, increased uptake of screenings and vaccines, a reduction in extremely low birthweight, and a reduction in infant mortality (Swartz et al. 2017). In this analysis we evaluate whether prenatal care is associated with maternal benefit. We specifically sought to determine whether prenatal care was effective in identifying high risk conditions and treating them to mitigate adverse outcomes. Our primary outcome is a composite maternal index of severe morbidity and mortality as defined by the Centers from Disease Control and Prevention (CDC) (Division of Reproductive Health, National Center for Chronic Disease Prevention and Health Promotion 2017).

Methods

The Oregon Health Authority's Department of Health Analytics provided medical claims data from January 1, 2003 through October 1, 2015 that included all pregnancies under standard Medicaid, Emergency Medicaid and Emergency Medicaid Plus. We obtained four types of quarterly data: recipient, claims, dental and prescription. Through administrative records and personal communication with the

Oregon Health Authority, we established start dates for the 36 county expansion of Emergency Medicaid Plus throughout Oregon (see Supplemental Appendix Figure 1).

We leveraged this natural experiment to evaluate how prenatal care coverage impacted a composite score of maternal morbidity and mortality.

Study Oversight

Institutional Review Board approval was obtained from Oregon Health & Science University (Protocol 15633) and Stanford University (Protocol 40907) and has been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. The study is based on de-identified patient data and so informed consent of subjects is not applicable.

Study Registration

Unless noted, all outcomes and analyses were pre-registered and posted in a pre-analysis plan with Evidence in Governance and Politics ("Design Registrations | Egap," n.d.).

Study Sample

Our population includes all women in the Oregon Medicaid claims database aged 12–51 with a pregnancy related claim. This sample includes women utilizing either Emergency Medicaid or Emergency Medicaid Plus. For pregnancies resulting in a live birth, maternal records were linked with claims for the offspring of that pregnancy. We included claims for linked pregnancies through 1 year of life for the infant. Research has shown that the vast majority of individuals using this program are unauthorized, and we will therefore refer to them as unauthorized immigrants (California Health Care Foundation 2013; DuBard and Massing 2007).

For our assessment of the effects of the prenatal care program we analyzed data at the level of pregnancy and included pregnancies resulting in live birth or stillbirth. Exclusion criteria included multiple gestations and pregnancies resulting in miscarriage, abortion, ectopic pregnancy, molar pregnancies and other early pregnancy losses. We identified pregnancy episodes using *International Statistical Classification of Diseases and Related Health Problems, Ninth Revision* diagnosis codes (ICD-9), and an established algorithm which has previously been published (Swartz et al. 2017). To match mothers and infants, we used a validated household identification number and auxiliary data with a matching algorithm, also described elsewhere (Angier et al. 2014; Swartz et al. 2017).

Outcomes

In this analysis, we provide a detailed evaluation of maternal care utilization, using the Adequacy of Prenatal Care Utilization Index (Kotelchuck 1994b). Prenatal visits were identified with prenatal supervision codes counted for each distinct day of service. The index categorizes women as having received Adequate Plus, Adequate, Intermediate or Inadequate care based on whether they initiated care in the first trimester of pregnancy, and how many visits were attended compared to the expected number (Kotelchuck a, 1994b).

For health outcomes, we used ICD-9 codes and Current Procedural Terminology (CPT) codes to identify diagnoses and procedures related to individual claims. We organized this analysis in three parts to help mitigate the influence of ascertainment bias on our results. By definition, women with Emergency Medicaid Plus had greater access to medical care. With more frequent visits and contact with the health system, we hypothesized we would find an increased probability of diagnosis of high risk conditions such as pre-existing diabetes mellitus, gestational diabetes mellitus (GDM), hypertensive disorders of pregnancy, maternal drug use in pregnancy, history of preterm delivery in a prior pregnancy, poor fetal growth and tobacco use in pregnancy. We included claims occurring at any time during the pregnancy for diagnosis of these conditions (Codes available in the Supplementary Appendix, Table 1).

In the second part of this analysis, we looked at complications of pregnancy, including those complications related to the high risk conditions specified above. As women with access to Emergency Medicaid only had coverage for the delivery and emergent conditions occurring during the pregnancy, we limited our comparison of complications that might occur with delivery or immediately postpartum to 5 days surrounding delivery; 1 day prior to the date of delivery and 4 days following (the maximum covered hospital stay after an uncomplicated cesarean delivery). Our primary outcome is a composite outcome for severe maternal morbidity and mortality from the CDC (Division of Reproductive Health, National Center for Chronic Disease Prevention and Health Promotion 2017). This measure includes a total of 21 indicators which are medical conditions not restricted to pregnancy (e.g. myocardial infarction, acute renal failure), diagnoses specific to pregnancy (e.g. eclampsia, amniotic fluid embolism), and procedures (e.g. blood transfusion, ventilation, hysterectomy) (Specific codes available in Table 2 in the Supplementary Appendix).

For the third part of our comparison, we hypothesized that those women most likely to benefit from prenatal care would be a cohort of medically high-risk women. We anticipated women with Emergency Medicaid Plus were more likely to be identified as high risk. To avoid ascertainment bias, we defined a high-risk cohort limited to women with

one or more births in the database prior to the introduction of the Emergency Medicaid Plus program. This cohort included women who had outcomes or conditions in these earlier pregnancies that would increase their risk in subsequent pregnancies (Conditions listed in Supplementary Appendix, Table 3). We compared birth outcomes among high risk women who gained access to Emergency Medicaid Plus to those women who did not in their subsequent pregnancies.

Statistical Analysis

Using the staggered rollout of the Emergency Medicaid Plus, we employ a difference-in-differences approach to identify the effects of expanding prenatal care to unauthorized immigrant women. Difference-in-differences methodology is gaining popularity in health policy research and has advantages over more traditional pre- and post-policy comparisons (Dimick and Ryan 2014). By measuring change in an outcome over time for both treatment and control counties we are able to control for unobserved common-shocks and time-invariant characteristics (Dimick and Ryan 2014). By including county specific time trends, we are also able to control for secular trends in the outcome unrelated to the policy change.

We use the following baseline specification, as described in (Swartz et al. 2017):

$$Y_{ijt} = \alpha + \pi Z_{ijt} + \theta K_{ijt} + \beta_j + \beta_t + \beta_{cj} T + \varepsilon_{ijt}$$

where Y_{ijt} is the outcome of interest for pregnancy i in county j and month$t$, Z_{ijt} is a treatment indicator, coded 1 if Emergency Medicaid Plus was offered in the county where the woman was enrolled at the end of pregnancy i, and 0 otherwise, K_{ijt} is a vector of time varying controls (including an age polynomial and fixed effects for race categories, ethnicity categories, and gravidity, defined as the number of pregnancies identified between 2003 and 2015), β_j are county-level fixed effects, β_t are monthly period fixed effects, $\beta_{cj} T$ are county specific time trends, and ε is the error term.

The model includes county and period fixed effects to account for all time-invariant common confounders that vary by month. We also include county-specific time trends that account for any changes in unobserved confounders that vary at the county level and affect outcomes smoothly over time. This relaxes the usual parallel trends assumption of the standard difference-in-differences model since our model explicitly allows for generic county-specific trends. In other words, the effects of the program are identified based on sudden changes in the outcomes that represent breaks away from the county specific trends and coincide with the start of the program. The model estimates an intention-to-treat effect (π): the effect of offering prenatal care as a county switches from Emergency Medicaid to Emergency Medicaid Plus. Standard errors are clustered at the county level. As a robustness check, we extend our analysis using a triple differences framework, including a third comparison group of women from standard Medicaid, to guard against confounding trends within a county that might only be associated with the immigrant population.

Results

Our resulting sample included a total of 213,746 pregnancies. Emergency Medicaid covered 16.5% of all pregnancies, Emergency Medicaid Plus 5.9% of pregnancies and Medicaid 77.7% of pregnancies in our database (see Table 4 in the Supplementary Appendix). Our high-risk cohort included a total of 20,770 pregnancy episodes. Of these high risk pregnancies, 7.4, 6.5 and 86.1% were covered by Emergency Medicaid, Emergency Medicaid Plus and Medicaid respectively.

Baseline demographic characteristics were evaluated for all three insurance programs (Supplementary Appendix, Table 4). As expected, women in Emergency Medicaid were predominantly Hispanic (80%, SD 0.40) and Emergency Medicaid Plus (77%, SD 0.42) and non-white (85%, SD 0.36 Emergency Medicaid, 77%, SD 0.42 Emergency Medicaid Plus), whereas the Medicaid population was predominantly non-Hispanic (80%, SD 0.40) and White (74%, SD 0.44). The Emergency Medicaid Plus (28.8 years, SD 5.94) population was slightly older than women in Emergency Medicaid (27.0 years, SD 5.80) and Medicaid (25.4 years, SD 5.57) at the time of delivery. Women were of similar gravidity in the three groups (Emergency Medicaid Plus 1.82 prior pregnancies, SD 0.95; Emergency Medicaid 1.40 prior pregnancies, SD 0.68; Medicaid 1.60 prior pregnancies 0.98).

Utilization

Coverage of prenatal care resulted in high levels of utilization and receipt of adequate prenatal care (Fig. 1). Prior to roll out of Emergency Medicaid Plus, overall, 99.2% of all Emergency Medicaid pregnancies had inadequate prenatal care, as compared with 51.3% of standard Medicaid recipients (Table 1). Findings were similar when we examined adequacy of care prior to Emergency Medicaid Plus in our high risk cohort (Table 2). Implementation of Emergency Medicaid Plus reduced inadequate care (all pregnancies −31.8%, 95% CI −34.5; −29.0; high risk pregnancies −38.6%, 95% CI −44.2; −33.0) to levels comparable to women in standard Medicaid (Tables 3, 4).

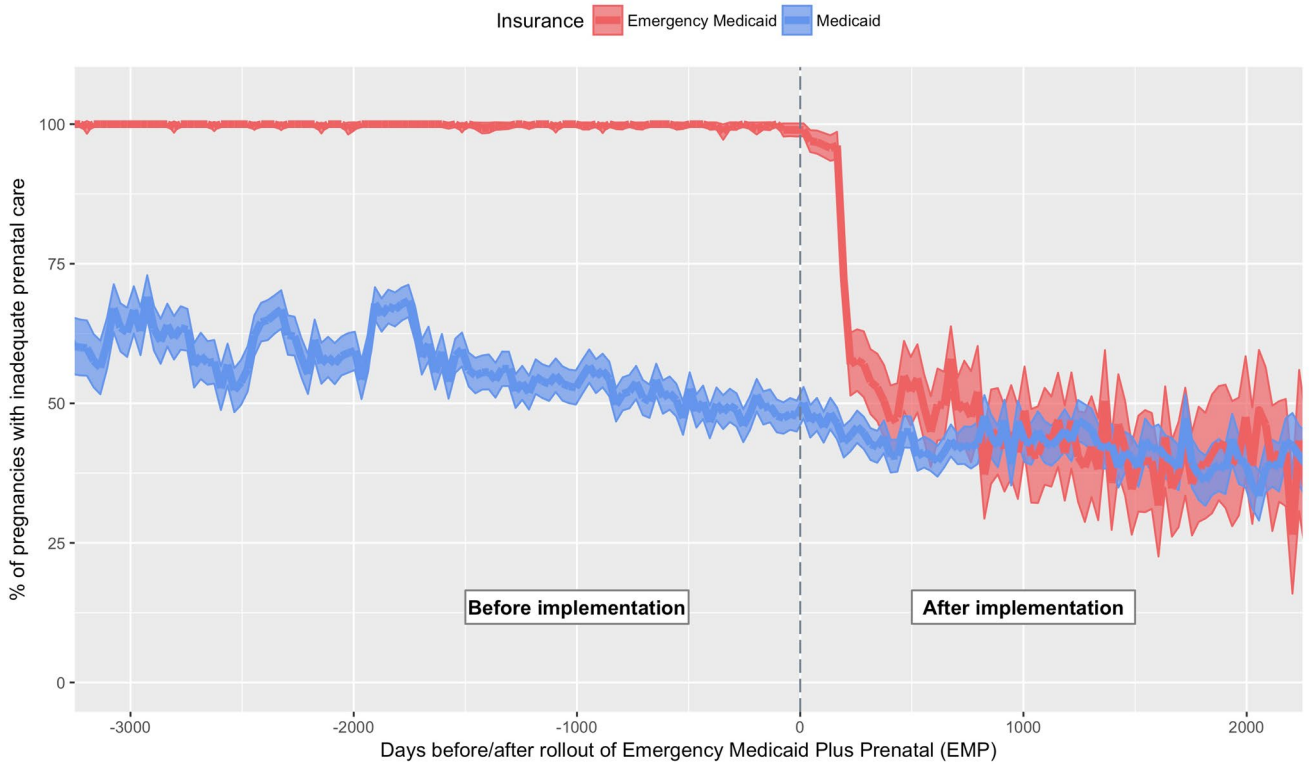

Fig. 1 Effect of Emergency Medicaid Plus Prenatal program on adequacy of prenatal care. Figure is in event time, with 0, above, representing the timing of county-level intervention of the Emergency Medicaid Plus program

Detection of Complications of Pregnancy

Emergency Medicaid Plus was associated with significantly improved detection of complications among all pregnancies. In our all-pregnancy sample, preexisting diabetes detection improved from 1.8% of Emergency Medicaid pregnancies to 6.1% of Emergency Medicaid Plus pregnancies (Table 1). This pattern persisted across all health conditions and in our model. Table 3 shows the estimates of the effect of Emergency Medicaid Plus on detection of complications among our all-pregnancy cohort.

Women with Emergency Medicaid Plus were more likely to be diagnosed as having pre-existing diabetes mellitus (all pregnancies 2.93%, 95% CI 2.16; 3.69), GDM (6.24%, 95% CI 4.36; 8.13), hypertensive diseases of pregnancy (1.28%, 95% CI 0.52; 2.04), a history of preterm birth (0.87%, 95% CI 0.27; 1.47) and poor fetal growth (7.37%, 95% CI 5.69; 9.05). History of preterm birth was not significant in the triple difference model (Table 3).

Among the high risk pregnancy cohort, we also saw increased detection effects of the Emergency Medicaid Plus program, although fewer effects achieved statistical significance (Table 4). Significant effects included that women with Emergency Medicaid Plus were more likely to be diagnosed with GDM (10.48%, 95% CI 5.87; 15.08), and poor fetal growth (5.34%, 95% CI 1.00; 9.68) (Table 4).

Birth Outcomes

We then examined the effect of Emergency Medicaid Plus on reducing severe maternal morbidity, our primary outcome. We found that Emergency Medicaid Plus had no significant effect on severe maternal morbidity (all-pregnancies 0.05%, 95% CI −0.29; 0.39; high-risk pregnancies 1.96, 95% CI −0.68; 4.60).

Emergency Medicaid Plus was associated with a reduction in the rate of shoulder dystocia (all pregnancies −0.60%, 95% CI −1.20; −0.00; high risk pregnancies −1.41%, 95% CI −2.54; −0.28). This effect was not significant in the triple difference model (all pregnancies −0.16%, 95% CI −0.65; 0.33, high risk pregnancies −0.42%, 95% CI −1.38; 0.54). Other effects on birth outcomes were not statistically significant. (Tables 3, 4).

Discussion

Though prenatal care is considered essential preventive care, the effects of prenatal care for women and infants are difficult to study. In this study, we were able to leverage the

Table 1 Descriptive statistics: detection outcomes and adequacy of care by insurance group

Insurance	Emergency Medicaid (EM)	Emergency Medicaid Plus Prenatal (EMP)	Medicaid	EM vs. EMP
Adequacy of prenatal care				
Inadequate	99.17 (9.06)	52.92 (49.92)	51.33 (49.98)	−46.26 [−47.14; −45.38]
Intermediate	0.26 (5.05)	7.95 (27.06)	15.88 (36.55)	7.70 [7.22; 8.17]
Adequate	0.21 (4.55)	11.94 (32.43)	11.56 (31.97)	11.73 [11.16; 12.31]
Adequate plus	0.36 (6.02)	27.19 (44.49)	21.23 (40.90)	26.82 [26.04; 27.60]
Detection outcomes				
Preexisting diabetes mellitus	1.77 (13.20)	6.09 (23.92)	3.53 (18.45)	4.32 [3.88; 4.76]
Gestational diabetes mellitus	7.61 (26.51)	19.00 (39.23)	10.21 (30.28)	11.39 [10.65; 12.14]
Maternal illicit drug use	0.22 (4.67)	0.80 (8.91)	13.43 (34.10)	0.58 [0.42; 0.74]
Hypertensive diseases of pregnancy	6.18 (24.08)	8.98 (28.59)	12.51 (33.08)	2.80 [2.24; 3.36]
History of preterm delivery in prior pregnancy	1.05 (10.19)	2.77 (16.40)	1.91 (13.70)	1.72 [1.41; 2.02]
Poor fetal growth	1.48 (12.07)	9.39 (29.17)	11.20 (31.54)	7.91 [7.39; 8.44]
Tobacco use in pregnancy	0.16 (3.95)	0.53 (7.24)	14.33 (35.04)	0.37 [0.24; 0.50]
Birth outcomes				
Severe maternal morbidity	1.66 (12.79)	1.93 (13.77)	1.78 (13.24)	0.27 [−0.00; 0.55]
Placental abruption	0.82 (9.00)	1.04 (10.14)	1.03 (10.10)	0.22 [0.02; 0.42]
Shoulder dystocia	2.83 (16.58)	2.65 (16.07)	2.14 (14.46)	−0.17 [−0.50; 0.16]
Eclampsia	0.11 (3.24)	0.03 (1.79)	0.13 (3.62)	−0.07 [−0.12; −0.03]
Vaginal delivery	74.10 (43.81)	74.38 (43.65)	74.23 (43.74)	0.28 [−0.61; 1.17]
Cesarean section	25.54 (43.61)	26.77 (44.28)	25.64 (43.67)	1.23 [0.33; 2.13]
Successful VBAC	2.33 (15.09)	3.87 (19.29)	1.28 (11.23)	1.54 [1.17; 1.91]
Infant birth injury	4.99 (21.77)	4.50 (20.73)	4.17 (19.99)	−0.49 [−0.91; −0.06]
Electrolyte disturbance attributed to maternal diabetes	6.48 (24.62)	9.00 (28.62)	6.87 (25.30)	2.52 [1.96; 3.08]
Preterm birth < 37 weeks	6.62 (24.86)	7.51 (26.35)	7.83 (26.86)	0.89 [0.36; 1.42]
Postpartum complications	2.33 (15.07)	3.25 (17.74)	4.50 (20.74)	0.93 [0.58; 1.28]

EM Emergency Medicaid, *EMP* Emergency Medicaid Plus Prenatal. All outcome variables are measured as percentages (0–100). Columns 2–4 show means with standard deviations in parentheses. Column 5 shows the difference in means between EM and EMP with robust 95% confidence intervals. N = 35,182 for EM; N = 12,510 for EMP; N = 166,054 for Medicaid. All outcomes defined using ICD9 codes available in the supplementary appendix. Preterm birth was defined as < 37 weeks and using ICD9 codes. Adequate prenatal care defined using the Adequate Prenatal Care Utilization Index, or the Kotelchuck index

staggered roll out of a policy change that resulted in differential access to care by county. We found that access to prenatal care had robust effects on the detection of complications and high risk conditions during pregnancy. These results suggest that in the Emergency Medicaid population, which functions as our control group, a significant percentage of high risk conditions like pre-existing diabetes mellitus, GDM and hypertensive disorders go undiagnosed, and presumably untreated. We had hypothesized that increased detection of complications would translate to a reduction in severe maternal morbidity, our primary outcome. However, we did not observe a significant reduction in severe maternal morbidity associated with receipt of prenatal care. This may be due to our inability to reliably follow Emergency Medicaid recipients through the entire postpartum period. The causes of maternal morbidity are diverse, complex, and can occur throughout the first 42 days postpartum (Maternal Morbidity Working Group et al. 2013). Emergency Medicaid coverage ends the day a woman gives birth. Our analysis was thus limited to complications occurring during the hospital admission, which biases our results towards the null.

Our findings, demonstrating an increase in utilization and detection of high risk conditions, have important public health and policy implications. Immigrant women face multiple barriers to accessing the health system and prenatal care (Derose et al. 2007). Previous studies have demonstrated that foreign-born women are less likely to use prenatal care, and that this disparity can have multigenerational consequences (Derose et al. 2007; Fuentes-Afflick and Lurie 1997). Low educational attainment, poverty, immigration status and language barriers may represent particularly important impediments to accessing care (Derose et al. 2007). Our study corroborates earlier work demonstrating increases in prenatal care utilization associated with CHIP, CHIPRA and state funding for prenatal care for this population (Drewry et al. 2015; Wherry et al. 2017). The sizeable decrease in

Table 2 Descriptive statistics: detection outcomes and adequacy of care by insurance group (high risk pregnancies)

Insurance	Emergency Medicaid (EM)	Emergency Medicaid Plus Prenatal (EMP)	Medicaid	EM vs. EMP
Adequacy of prenatal care				
Inadequate	97.91 (14.32)	46.05 (49.86)	31.96 (46.63)	−51.85 [−54.60; −49.10]
Intermediate	0.79 (8.83)	7.16 (25.79)	16.38 (37.01)	6.37 [4.93; 7.82]
Adequate	0.33 (5.71)	12.18 (32.71)	14.60 (35.31)	11.85 [10.08; 13.62]
Adequate plus	0.98 (9.86)	34.61 (47.59)	37.07 (48.30)	33.63 [31.05; 36.21]
Detection outcomes				
Preexisting diabetes mellitus	6.68 (24.97)	13.21 (33.87)	6.22 (24.16)	6.53 [4.34; 8.73]
Gestational diabetes mellitus	13.68 (34.37)	29.45 (45.60)	15.26 (35.96)	15.77 [12.79; 18.75]
Maternal illicit drug use	0.46 (6.76)	0.96 (9.75)	21.70 (41.22)	0.50 [−0.12; 1.12]
Hypertensive diseases of pregnancy	10.60 (30.80)	12.62 (33.22)	14.65 (35.36)	2.02 [−0.33; 4.37]
History of preterm delivery in prior pregnancy	13.35 (34.02)	12.92 (33.55)	10.66 (30.86)	−0.44 [−2.91; 2.03]
Poor fetal growth	1.70 (12.94)	9.37 (29.16)	11.93 (32.42)	7.67 [5.99; 9.35]
Tobacco use in pregnancy	0.26 (5.11)	0.89 (9.37)	25.74 (43.72)	0.62 [0.06; 1.18]
Birth outcomes				
Severe maternal morbidity	2.95 (16.91)	3.10 (17.34)	2.29 (14.97)	0.15 [−1.10; 1.41]
Placental abruption	1.31 (11.37)	0.96 (9.75)	1.44 (11.90)	−0.35 [−1.12; 0.42]
Shoulder dystocia	2.81 (16.54)	2.66 (16.09)	2.15 (14.51)	−0.16 [−1.35; 1.04]
Eclampsia	0.00 (0.00)	0.00 (0.00)	0.08 (2.80)	0.00 [0.00; 0.00]
Vaginal delivery	50.26 (50.02)	57.79 (49.41)	59.50 (49.09)	7.52 [3.89; 11.16]
Cesarean section	50.46 (50.01)	45.31 (49.80)	40.16 (49.02)	−5.14 [−8.79; −1.49]
Successful VBAC	5.50 (22.80)	9.00 (28.63)	3.02 (17.11)	3.51 [1.60; 5.41]
Infant birth injury	7.85 (26.91)	5.68 (23.16)	3.52 (18.42)	−2.17 [−4.00; −0.34]
Electrolyte disturbance attributed to maternal diabetes	13.35 (34.02)	14.69 (35.41)	10.00 (30.00)	1.34 [−1.21; 3.88]
Preterm birth < 37 weeks	10.08 (30.11)	11.29 (31.66)	9.92 (29.90)	1.21 [−1.05; 3.48]
Postpartum complications	3.14 (17.45)	3.76 (19.04)	5.05 (21.89)	0.62 [−0.72; 1.96]

EM Emergency Medicaid, *EMP* Emergency Medicaid Plus Prenatal. All outcome variables are measured as percentages (0–100). Columns 2–4 show means with standard deviations in parentheses. Column 5 shows the difference in means between EM and EMP with robust 95% confidence intervals. N = 1528 for EM; N = 1355 for EMP; N = 17887 for Medicaid. All outcomes defined using ICD9 codes available in the supplementary appendix. Preterm birth was defined as < 37 weeks and using ICD9 codes. Adequate prenatal care defined using the Adequate Prenatal Care Utilization Index, or the Kotelchuck index

inadequate prenatal care for all-pregnancies (−31.8% relative to the baseline mean of 99.2%) and high risk pregnancies (−38.6% relative to baseline 97.9%) is indicative of the important role that Medicaid plays in determining access to obstetric care. Moreover, rates of inadequate care for the Emergency Medicaid Plus population were similar to rates for women with Medicaid. This parity underscores the importance of Medicaid policy in determining access to prenatal care.

Policymakers should consider the potential for long term consequences for individual and community health when implementing policies that affect care during pregnancy. Previous research has demonstrated that laws requiring strict proof of citizenship prior to enrollment in Medicaid resulted in significant delays in prenatal care for U.S citizens and increased public costs (Bauer et al. 2011; Rodriguez et al. 2011). Data from Oregon demonstrated a 3 weeks delay in initiation of prenatal care when strict citizenship verification was required: this delay may increase health risks for women and their children (Bauer et al. 2011). Screening for citizenship has also been shown to increase public costs, resulting in a loss of $3119 per woman over 5 years, when strict proof of citizenship was required in family planning clinics in Oregon. The increased costs for the state were due to a significant decrease in adolescents being able to access care, and experiencing unintended pregnancies (Rodriguez et al. 2011). President Trump's 2019 budget calls for no federal funding for health care, until an individual's citizenship status has been verified (Office of Budget (OB), 2018). If implemented, this policy would likely have far reaching consequences for the health of women and children across the nation.

Reduction of diabetes and obesity is a public health priority and detection of high risk conditions during pregnancy may mitigate the burden of chronic disease. Among our all-pregnancy cohort, we observed a 161% increase in detection

Table 3 Effect of emergency medicaid plus prenatal on detection outcomes, birth outcomes, and adequacy of prenatal care

Outcome	DID model Effect [95% CI]	Triple DID model Effect [95% CI]
Adequacy of care		
Inadequate	−31.75 [−34.47; −29.02]	−32.40 [−36.48; −28.32]
Intermediate	6.36 [4.51; 8.21]	6.43 [4.40; 8.46]
Adequate	9.01 [7.86; 10.16]	9.08 [8.13; 10.03]
Adequate plus	16.38 [14.42; 18.34]	16.88 [12.83; 20.94]
Detection outcomes		
Preexisting diabetes mellitus	2.93 [2.16; 3.69]	3.53 [3.05; 4.00]
Gestational diabetes mellitus	6.24 [4.36; 8.13]	7.79 [6.27; 9.32]
Maternal illicit drug use	0.36 [0.00; 0.71]	−3.27 [−4.24; −2.30]
Hypertensive diseases of pregnancy	1.28 [0.52; 2.04]	0.87 [0.25; 1.49]
History of preterm delivery in prior pregnancy	0.87 [0.27; 1.47]	0.34 [−0.12; 0.80]
Poor fetal growth	7.37 [5.69; 9.05]	7.29 [5.17; 9.42]
Tobacco use in pregnancy	0.02 [−0.31; 0.35]	−3.67 [−4.85; −2.49]
Birth outcomes		
Severe maternal morbidity	0.05 [−0.29; 0.39]	0.37 [0.07; 0.66]
Placental abruption	0.25 [−0.10; 0.60]	0.14 [−0.12; 0.39]
Shoulder dystocia	−0.60 [−1.20; −0.00]	−0.16 [−0.65; 0.33]
Eclampsia	−0.05 [−0.12; 0.03]	−0.07 [−0.12; −0.01]
Vaginal delivery	−1.40 [−3.56; 0.76]	0.71 [−0.70; 2.12]
Cesarean section	1.74 [−0.12; 3.61]	0.03 [−0.92; 0.99]
Successful VBAC	−0.24 [−0.71; 0.24]	0.72 [0.17; 1.26]
Infant birth injury	−0.68 [−1.72; 0.35]	−0.53 [−1.71; 0.65]
Electrolyte disturbance attributed to maternal diabetes	−1.45 [−3.19; 0.28]	−0.06 [−0.78; 0.66]
Preterm birth < 37 weeks	0.19 [−0.84; 1.22]	0.98 [0.27; 1.69]
Postpartum complications	0.63 [−0.15; 1.40]	−0.05 [−3.25; 3.16]

Effect estimates from difference-in-differences model (DID) and triple differences model (Triple DID) with robust 95% confidence intervals (clustered by county) in parentheses. All outcome variables are measured as percentages (0–100). All models include county fixed effects, month fixed effects, county specific time-trends, and covariates (age polynomial, race fixed effects, ethnicity fixed effects, and gravidity fixed effects which are defined as the number of pregnancies identified between 2003 and 2015). N = 47,692 for DID models and N = 213,746 for Triple DID models. All outcomes defined using ICD9 codes available in the supplementary appendix. Preterm birth was defined as < 37 weeks and using ICD9 codes. Adequate prenatal care defined using the Adequate Prenatal Care Utilization Index, or the Kotelchuck index

of pre-existing diabetes, (2.9% absolute increase from a baseline mean of 1.8%) and an 82% increase in gestational diabetes mellitus (6.2% absolute increase from a baseline mean of 7.6%). Among high risk pregnancies, we saw a 77% increase in diagnosis of GDM (10.5% absolute increase from 13.7% at baseline). As pregnancy may exacerbate diabetes, optimizing care during the antenatal period can have long lasting health benefits for women and their children (ACOG Committee on Practice Bulletins 2005; Committee on Practice Bulletins–Obstetrics 2013; Moyer 2014). The small observed reduction in shoulder dystocia is plausibly due to improved diabetic care.

In contrast to prior studies using birth certificate data that used foreign-born status, Hispanic ethnicity and low educational attainment as proxies for program eligibility (Drewry et al. 2015; Wherry et al. 2017), we used a Medicaid claims database that allowed us to isolate the effects of policy change on the affected population. Use of Medicaid claims also helped us capture outcomes not recorded on birth certificates (Lain et al. 2012; Lydon-Rochelle et al. 2005). Finally, prior studies looking at the effects of these programs across multiple states had risk for confounding from the heterogeneity of the policy environments, health systems, and populations, for example, in those states.

Limitations

As with all administrative datasets, inaccuracies and omissions could affect our results. For example, women with Emergency Medicaid may have been receiving care prior to Emergency Medicaid Plus availability that would not appear in our database, if no claims were made. Sources of prenatal care include community health centers and other safety net providers that were providing care through alternative

Table 4 Effect of emergency medicaid plus prenatal on detection outcomes, birth outcomes, and adequacy of prenatal care (high risk cohort)

Outcome	DID model Effect [95% CI]	Triple DID model Effect [95% CI]
Adequacy of care		
Inadequate	−38.60 [−44.17; −33.02]	−43.52 [−52.23; −34.81]
Intermediate	6.05 [2.79; 9.31]	6.41 [3.27; 9.56]
Adequate	11.25 [7.59; 14.91]	10.57 [7.56; 13.57]
Adequate plus	21.30 [18.27; 24.33]	26.54 [19.20; 33.89]
Detection outcomes		
Preexisting diabetes mellitus	4.18 [−0.91; 9.26]	6.30 [3.54; 9.06]
Gestational diabetes mellitus	10.48 [5.87; 15.08]	12.99 [10.29; 15.69]
Maternal illicit drug use	0.47 [−0.94; 1.88]	−4.30 [−6.68; −1.91]
Hypertensive diseases of pregnancy	−0.08 [−3.22; 3.06]	−0.07 [−2.28; 2.14]
History of preterm delivery in prior pregnancy	1.13 [−4.00; 6.26]	0.89 [−1.38; 3.16]
Poor fetal growth	5.34 [1.00; 9.68]	7.84 [4.25; 11.44]
Tobacco use in pregnancy	0.34 [−0.22; 0.89]	−1.70 [−4.79; 1.39]
Birth outcomes		
Severe maternal morbidity	1.96 [−0.68; 4.60]	0.86 [−0.22; 1.93]
Placental abruption	−0.67 [−2.10; 0.77]	−0.36 [−1.26; 0.54]
Shoulder dystocia	−1.41 [−2.54; −0.28]	−0.42 [−1.38; 0.54]
Eclampsia	0.00 [0.00; 0.00]	−0.01 [−0.09; 0.07]
Vaginal delivery	−1.02 [−7.47; 5.43]	6.92 [2.24; 11.60]
Cesarean section	3.51 [−0.85; 7.86]	−5.46 [−11.06; 0.14]
Successful VBAC	0.16 [−2.88; 3.20]	1.81 [−0.43; 4.05]
Infant birth injury	−0.14 [−2.67; 2.40]	−1.49 [−3.79; 0.81]
Electrolyte disturbance attributed to maternal diabetes	−3.22 [−10.17; 3.73]	−0.90 [−2.75; 0.95]
Preterm birth < 37 weeks	0.05 [−2.85; 2.94]	2.39 [0.76; 4.02]
Postpartum complications	2.05 [−0.11; 4.22]	1.46 [−3.07; 5.99]

Effect estimates from difference-in-differences model (DID) and triple differences model (Triple DID) model with robust 95% confidence intervals (clustered by county) in parentheses. All outcome variables are measured as percentages (0–100). All models include county fixed effects, month fixed effects, county specific time-trends, and covariates (age polynomial, race fixed effects, ethnicity fixed effects, and gravidity fixed effects which are defined as the number of pregnancies identified between 2003 and 2015)]. N = 2883 for DID models and N = 20770 for Triple DID models. All outcomes defined using ICD9 codes available in the supplementary appendix. Preterm birth was defined as < 37 weeks and using ICD9 codes. Adequate prenatal care defined using the Adequate Prenatal Care Utilization Index or the Kotelchuk Index

funding mechanisms. Moreover, women with complicated pregnancies may have been more likely to seek care prior to the introduction of the program. This would bias our results towards the null in estimating health outcomes but overestimate the effect on utilization. Regarding external generalizability, Oregon is a small and relatively racially homogenous state and the Emergency Medicaid population less predominantly Hispanic ethnicity than other states (California Health Care Foundation 2013; DuBard and Massing 2007).

Conclusion

This study contributes to the body of evidence demonstrating the multigenerational positive effects of these programs for immigrant women and their children. The results can help policymakers considering funding or renewing similar programs in Oregon and other states.

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References

AAA. (2012). *Guidelines for perinatal care. American Academy of Pediatrics. American College of Obstetricians and Gynecologists* (7th ed.). Washington, DC: Elk Grove Village (IL).

ACOG Committee on Practice Bulletins. (2005). ACOG practice bulletin. Clinical Management guidelines for obstetrician-gynecologists. Number 60, March 2005. Pregestational diabetes mellitus. *Obstetrics and Gynecology, 105*(3), 675–685.

Angier, H., Gold, R., Crawford, C., O'Malley, J. P., Tillotson, C. J., Marino, M., & DeVoe, J. E. (2014). Linkage methods for connecting children with parents in electronic health record and state public health insurance data. *Maternal and Child Health Journal, 18*(9), 2025–2033. https://doi.org/10.1007/s10995-014-1453-8.

Bauer, J., Angus, L., Fischler, N., Rosenberg, K. D., Gipson, T. F., & Devoe, J. (2011). The impact of citizenship documentation requirements on access to medicaid for pregnant women in Oregon. *Maternal and Child Health Journal, 15*(6), 753–758. https://doi.org/10.1007/s10995-010-0632-5.

California Health Care Foundation. (2013). *Medi-Cal facts and figures: A program transforms*. Oakland: California Health Care Foundation. Retrieved from http://www.chcf.org/publications/2013/05/medical-facts-figures.

Carroli, G., Rooney, C., & Villar, J. (2001). How effective is antenatal care in preventing maternal mortality and serious morbidity? An overview of the evidence. *Paediatric and Perinatal Epidemiology, 15*(s1), 1–42.

Committee on Practice Bulletins–Obstetrics. (2013). Practice bulletin no. 137: Gestational diabetes mellitus. *Obstetrics and Gynecology, 122*(2 Pt 1), 406–416. https://doi.org/10.1097/01.AOG.0000433006.09219.f1.

Dahlen, H. M., McCullough, J. M., Fertig, A. R., Dowd, B. E., & Riley, W. J. (2017). Texas medicaid payment reform: Fewer early elective deliveries and increased gestational age and birthweight. *Health Affairs (Project Hope), 36*(3), 460–467. https://doi.org/10.1377/hlthaff.2016.0910.

Derose, K. P., Escarce, J. J., & Lurie, N. (2007). Immigrants and health care: Sources of vulnerability. *Health Affairs, 26*(5), 1258–1268. https://doi.org/10.1377/hlthaff.26.5.1258.

Design Registrations | Egap. (n.d.). Retrieved May 9, 2017, from http://egap.org/design-registrations.

Dimick, J. B., & Ryan, A. M. (2014). Methods for evaluating changes in health care policy: The difference-in-differences approach. *JAMA, 312*(22), 2401–2402. https://doi.org/10.1001/jama.2014.16153.

Division of Reproductive Health, National Center for Chronic Disease Prevention and Health Promotion. (2017). Severe Maternal Morbidity in the United States | Pregnancy | Reproductive Health |CDC. Retrieved March 2, 2018, from https://www.cdc.gov/reproductivehealth/maternalinfanthealth/severematernalmorbidity.html.

Drewry, J., Sen, B., Wingate, M., Bronstein, J., Foster, E. M., & Kotelchuck, M. (2015). The impact of the state children's health insurance program's unborn child ruling expansions on foreign-born Latina prenatal care and birth outcomes, 2000–2007. *Maternal and Child Health Journal, 19*(7), 1464–1471. https://doi.org/10.1007/s10995-014-1650-5.

DuBard, C. A., & Massing, M. W. (2007). Trends in emergency medicaid expenditures for recent and undocumented immigrants. *JAMA: The Journal of the American Medical Association, 297*(10), 1085–1092.

Fuentes-Afflick, E., & Lurie, P. (1997). Low birth weight and Latino ethnicity. Examining the epidemiologic paradox. *Archives of Pediatrics & Adolescent Medicine, 151*(7), 665–674.

Iams, J. D., Applegate, M. S., Marcotte, M. P., Rome, M., Krew, M. A., Bailit, J. L., … Lannon, C. (2017). A statewide progestogen promotion program in Ohio. *Obstetrics and Gynecology, 129*(2), 337–346. https://doi.org/10.1097/AOG.0000000000001841.

Johnson, K., Applegate, M., & Gee, R. E. (2015). Improving medicaid: Three decades of change to better serve women of childbearing age. *Clinical Obstetrics and Gynecology, 58*(2), 336–354. https://doi.org/10.1097/GRF.0000000000000115.

Kotelchuck, M. (1994a). An evaluation of the Kessner Adequacy of Prenatal Care Index and a proposed Adequacy of Prenatal Care Utilization Index. *American Journal of Public Health, 84*(9), 1414–1420.

Kotelchuck, M. (1994b). The adequacy of prenatal care utilization index: Its US distribution and association with low birthweight. *American Journal of Public Health, 84*(9), 1486–1489.

Lain, S. J., Hadfield, R. M., Raynes-Greenow, C. H., Ford, J. B., Mealing, N. M., Algert, C. S., & Roberts, C. L. (2012). Quality of data in perinatal population health databases: A systematic review. *Medical Care, 50*(4), e7–e20. https://doi.org/10.1097/MLR.0b013e31821d2b1d.

Lu, M. C., Lin, Y. G., Prietto, N. M., & Garite, T. J. (2000). Elimination of public funding of prenatal care for undocumented immigrants in California: A cost/benefit analysis. *American Journal of Obstetrics and Gynecology, 182*(1 Pt 1), 233–239.

Lydon-Rochelle, M. T., Holt, V. L., Nelson, J. C., Cárdenas, V., Gardella, C., Easterling, T. R., & Callaghan, W. M. (2005). Accuracy of reporting maternal in-hospital diagnoses and intrapartum procedures in Washington State linked birth records. *Paediatric and Perinatal Epidemiology, 19*(6), 460–471. https://doi.org/10.1111/j.1365-3016.2005.00682.x.

Maternal Morbidity Working Group, Firoz, T., Chou, D., von Dadelszen, P., Agrawal, P., Vanderkruik, R., … Say, L. (2013). Measuring maternal health: Focus on maternal morbidity. *Bulletin of the World Health Organization, 91*(10), 794–796.

Markus, A. R., Andres, E., West, K. D., Garro, N., & Pellegrini, C. (2013). Medicaid covered births, 2008 through 2010, in the context of the implementation of health reform. *Women's Health Issues, 23*(5), e273–e280.

Mbuagbaw, L., Medley, N., Darzi, A. J., Richardson, M., Habiba Garga, K., & Ongolo-Zogo, P. (2015). Health system and community level interventions for improving antenatal care coverage and health outcomes. *The Cochrane Database of Systematic Reviews, 12*, CD010994. https://doi.org/10.1002/14651858.CD010994.pub2.

Moyer, V. A. (2014). Screening for gestational diabetes mellitus: U.S. preventive services task force recommendation statement. *Annals of Internal Medicine, 160*(6), 414–420. https://doi.org/10.7326/M13-2905.

Office of Budget (OB), A. S. for F. R. (ASFR). (2018). FY 2019 budget & performance [Text]. Retrieved March 2, 2018, from https://www.hhs.gov/about/budget/index.html.

Rodriguez, M. I., Angus, L., Elman, E., Darney, P. D., & Caughey, A. B. (2011). Financial effect of instituting Deficit Reduction Act documentation requirements in family planning clinics in Oregon. *Contraception, 83*(6), 537–541.

Swartz, J. J., Darney, B. G., Caughey, A. B., & Rodriguez, M. I. (2015). Obstetrics drives emergency medicaid spending: Trends in Oregon's Emergency Medicaid Program over 35 months.

Swartz, J. J., Hainmueller, J., Lawrence, D., & Rodriguez, M. I. (2017). Expanding prenatal care to unauthorized immigrant women and the effects on infant health. *Obstetrics and Gynecology*. https://doi.org/10.1097/AOG.0000000000002275.

Vintzileos, A. M., Ananth, C. V., Smulian, J. C., Scorza, W. E., & Knuppel, R. A. (2002). The impact of prenatal care in the United States on preterm births in the presence and absence of antenatal high-risk conditions. *American Journal of Obstetrics and Gynecology, 187*(5), 1254–1257.

Wherry, L. R., Fabi, R., Schickedanz, A., & Saloner, B. (2017). State and federal coverage for pregnant immigrants: Prenatal care increased, no change detected for infant health. *Health Affairs, 36*(4), 607–615. https://doi.org/10.1377/hlthaff.2016.1198.

WHO Recommendations on Health Promotion Interventions for Maternal and Newborn Health. (2015). Geneva: World Health Organization. Retrieved from http://www.ncbi.nlm.nih.gov/books/NBK304983/.