



Maternal Health

Antenatal Maternity Leave and Childbirth Using the First Baby Study: A Propensity Score Analysis



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A B S T R A C T

Background: Most employed American women work during pregnancy and continue working through the month they deliver. Yet, few studies estimate the relationship between maternity leave taken during pregnancy and maternal health. We evaluate the association of antenatal leave (ANL) uptake with obstetric outcomes, assessing the potential role of protective and adverse selection pathways on this relationship.

Methods: We sample 1,740 employed women who delivered at term from the First Baby Study, a prospective cohort of nulliparous women in Pennsylvania. We use propensity scores to estimate the relationship between ANL and negative delivery outcomes (labor induction, long labor duration, unplanned cesarean delivery, and self-reported negative birth experience). We estimated propensity scores using a range of employment, health, and sociodemographic variables.

Results: One-half of the sampled women worked until the day before or day of delivery. Women who stopped working at least 2 days before delivery experienced 16% more negative delivery outcomes, on average, than women who worked until delivery, driven largely by a 25% higher predicted probability of unplanned cesarean section deliveries. These robust findings hold up to a range of sensitivity analyses and demonstrate selective mechanisms operating in ANL uptake.

Conclusion: Our findings suggest that, even after controlling for an extensive set of observable employment, health, and sociodemographic characteristics, women who take ANL continue to differ in unobserved characteristics that lead to negative delivery outcomes. Like most U.S. states, Pennsylvania does not grant paid maternity leave. In a context of limited maternity leave availability, only relatively unhealthy women take ANL.

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Women's participation in the labor force during pregnancy has changed dramatically over the past 50 years. Increasingly, American women are employed during pregnancy and those who hold jobs work later into their pregnancies. In 2006 to 2008, 66% of first-time mothers worked during pregnancy, up from 44% in 1961 to 1965 (Laughlin, 2011). Of those, 82% worked in the month they delivered.

This increase in prenatal employment has sparked interest in the health effects of work on pregnancy and childbirth. Studies examining the relationship between psychological aspects of work and health yield inconsistent results, but strong evidence suggests that strenuous physical work (e.g., prolonged standing, bending, working the night shift) adversely affects birth outcomes (Bonzini et al., 2011; Del Bono, Ermisch, & Francesconi, 2012; Mozurkewich, Luke, Avni, & Wolf, 2000). For example, a meta-analysis based on 160,988 women in 29 observational studies found that strenuous physical work was significantly associated with preterm delivery, small-for-gestational-age infants, and hypertension or preeclampsia (Mozurkewich et al., 2000).

A few studies have examined the relationship between antenatal maternity leave and obstetric outcomes. In a sample of full-time employed California women who delivered at term, Guendelman, Pearl, Graham, Angulo, and Kharrazi (2009) found

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decreased odds of primary cesarean section among women who took leave in the ninth month of pregnancy (odds ratio [OR], 0.27; 95% confidence interval [CI], 0.08–0.94) compared with those who worked until delivery after adjusting for gestational age, infant sex, maternal race, parity, prepregnancy body mass index, height, and occupation. The 62 women who took antenatal leave (ANL) did not differ demographically from the 385 women who did not take leave, but the statistical power was limited in this small sample. Similarly, in their study of women who worked at least through their first trimester and who delivered full-term infants in Montreal, Canada, [Xu, Séguin, and Goulet \(2002\)](#) found that longer work stoppage before delivery was associated with a slightly reduced odds of difficult delivery defined as emergency cesarean section delivery (C-section), induced labor, instrumental delivery, long labor duration, maternal hemorrhage, and labor augmentation (OR, 0.96; 95% CI, 0.93–0.99). Both studies were conducted in locations where paid, job-protected maternity leave is available through existing social policies.

Using the nationally representative Infant Feeding Practices Study, [Hung, Morrison, Whittington, and Fein \(2002\)](#) examined characteristics of prenatal work and mode of delivery. Women who worked full time with no plan to stop before delivery did not have an increased risk of C-section compared with women in part-time work with plans to stop before delivery, although women with mid-level work intensity (full time planning on stopping or part time not planning on stopping) had a lower risk of C-section than part-time women with plans to stop before delivery (OR, 0.62; 95% CI, 0.04–1.04; OR, 0.64; 95% CI, 0.45–0.91, respectively). Like women who are not employed during pregnancy, women working part time with plans to stop before delivery may have other unobserved characteristics that put them at greater risk of obstetric complications, although the study included only women without major postpartum health problems.

The relationship between ANL and obstetric outcomes among women reaching full-term pregnancy without major complications might operate through two distinct pathways—protection and adverse selection—each leading to a different directional effect. Through the “protection” pathway, ANL proactively removes women from a stressful or strenuous work environment and allows them to rest and sleep at the end of pregnancy, leading to positive maternal health outcomes. Labor demands physical stamina; preventing women from beginning labor exhausted after a full day at work could reduce the risk of prolonged labor, C-sections, and other obstetric complications, which have been linked to fatigue and poor sleep ([Chien & Ko, 2004](#); [Lee & Gay, 2004](#); [Mayberry, Gennaro, Strange, Williams, & De, 1999](#)). Furthermore, evidence shows that women with greater maternal prenatal stress are more likely to perceive pain, receive analgesia, and deliver surgically ([Saunders, Lobel, Veloso, & Meyer, 2006](#)).

Through the “adverse selection” pathway, women take ANL only when they feel they can no longer perform their jobs, rather than as a protective, proactive measure. Particularly in the United States, where ANL is not the norm and access to paid maternity leave is not available widely, ANL uptake may be more likely among women who have pregnancy complications and these risks in turn may lead to adverse obstetric outcomes. Therefore, taking ANL may be associated with negative maternal health outcomes because only the least healthy women stop working. For instance, one study of women employed at least 20 hours per week during pregnancy in California found that working the night shift, lack of fulfillment in one's job, and being stressed

and/or tired were associated with a higher odds of taking ANL ([Guendelman, Pearl, Graham, Angulo, & Kharrazi 2006](#)). A study of employed pregnant women in Georgia found that more than one-quarter (27.7%) were advised by a health care provider to stop working during pregnancy and that being so advised significantly decreased the likelihood that women continued working into their ninth month of pregnancy ([Frazier, Golbeck, & Lipscomb, 2001](#)). Importantly, this pathway does not preclude women from benefiting from ANL (e.g., by removing themselves from a strenuous work environment or resting before delivery), but this benefit might be masked by the risk profile of women using ANL in the United States.

Our study examines the association between ANL uptake and maternal health in the perinatal period. We examine two competing hypotheses, namely, whether ANL among women who take it exerts a protective role that buffers against adverse obstetric outcomes or an overwhelming selective role that directs mostly women who are at risk of medical complications to take ANL, while healthier women tend to forego leave. We focus on women who delivered in Pennsylvania, a state that, like most other U.S. states, does not offer paid leave. We use both propensity score matching and multivariable regression models with a rich dataset that includes detailed information on women's experiences during pregnancy, labor and delivery, and postpartum to assess a range of obstetric outcomes. We include a novel and expansive set of covariates that capture prenatal physical and mental health more comprehensively than prior studies and allow us to better address the endogeneity of ANL.

Material and Methods

We conducted secondary analysis of the First Baby Study (FBS), a prospective telephone interview study of 3,006 women designed to investigate the association between mode of delivery and subsequent fertility over the course of a 3-year follow-up period after a first birth ([Kjerulff et al., 2013](#)). We used data from the baseline interview, conducted when participants were between 30 and 42 weeks pregnant (median gestational age, 35 weeks), and a 1-month postpartum interview. Birth certificate and hospital discharge data were obtained for the women who completed the baseline and 1-month follow-up interviews. Details of the sampling design and recruitment procedure are described elsewhere ([Kjerulff et al., 2013](#)).

Eligible respondents spoke English or Spanish, were between 18 and 35 years of age, nulliparous, pregnant with a singleton, and planning to deliver in a Pennsylvania hospital. We excluded five women who stopped working more than 30 days before delivery because longer leave may indicate serious health problems that are associated independently with adverse outcomes. Furthermore, first-time mothers who stop working more than 2 months before delivery more likely quit or were fired than women who stop later, according to U.S. Census data ([Laughlin, 2011](#)). After excluding women who were not employed during pregnancy, women who delivered preterm and did not have a chance to take ANL, women who stopped working more than 30 days before delivery, and women who quit or were fired, our analytic sample included 1,743 employed pregnant women. We then dropped three women with missing ANL data, resulting in a final unweighted sample of 1,740 women. The project was approved by the Penn State College of Medicine and by the ethics committees of participating hospitals across the state.

Compared with a population of first, singleton births among women aged 18 to 36 in Pennsylvania in 2008, women in the FBS

were slightly older, more likely to be White, more likely to be more educated, more likely to have private insurance, and more likely to be married; they did not differ in likelihood of delivering by C-section (Kjerulff et al., 2013).

Dependent Variables

The two primary dependent variables were whether women experienced at least one of the following negative delivery outcomes: induction of labor, labor lasting longer than 24 hours, unplanned cesarean delivery, or self-reported negative delivery experience, and the number of such outcomes experienced. All outcomes were measured at the 1-month postpartum interview. Negative birth experience was measured using a 16-item questionnaire, the FBS Birth Experience Scale (Kinsey, Baptiste-Roberts, Zhu, & Kjerulff, 2013), which was developed by the FBS investigators and pilot tested before use. It asks mothers to rate how they felt right after having their baby (or if unconscious, after waking up) on a scale of 1 (extremely) to 5 (not at all). The scale includes brief adjectives or statements from each of the four subdimensions of birth experience (emotional adaptation, physical discomfort, fulfillment, and negative emotional experience). Possible scores range from 16 to 80, with a higher score indicating more a positive birth experience; Cronbach's α was 0.73. The quintile of women with the lowest scores on the scale represents those having a negative birth experience (Elvander, Cnattingius, & Kjerulff, 2013).

Independent Variable

ANL measured the amount of time before delivery that employed women stopped working with the intention to return to their same employer. At the 1-month postpartum interview, women who were still employed at the end of pregnancy were asked how long before their child was born they stopped working. Respondents reported the number of days before delivery they stopped working or responded that they had the baby the same day they worked.

Holding no prior hypothesis for how much ANL constitutes a sufficient exposure to effect results, we focused on whether women took any leave, defined as stopping work at least 2 days before delivery. We considered women who worked until the day before they delivered to have taken no leave because they may have stopped working owing to labor beginning and did not actually have any leave from work.

Covariates

We selected covariates that have been shown in the literature to influence ANL, perinatal outcomes, or both, and that precede treatment status. We measured all covariates at the baseline interview, unless otherwise noted. We included all covariates in our models used to estimate propensity scores, as well as unmatched multivariable regression models.

Employment variables included full-time versus part-time employment status and occupational category (service or labor vs. professional, managerial, or clerical). Health variables included prepregnancy obesity and whether the woman gained more weight than recommended during pregnancy (Institute of Medicine & National Research Council, 2009; both measured at the 1-month postpartum interview), prior miscarriage, self-reported history of diabetes or hypertension before pregnancy, presence of medical problems during current pregnancy

(hypertension, high blood pressure, or preeclampsia that started during pregnancy), diabetes that started during pregnancy, vaginal bleeding, early or preterm labor, bed rest or hospitalization because of premature labor, number of hospitalizations during pregnancy, number of doctor office or urgent care visits in the last month of pregnancy; whether the woman received help getting pregnant; whether a provider advised a C-section during pregnancy; fear of childbirth measured with the FBS Birth Anticipation Scale, preference for vaginal delivery, prenatal stress using the Perceived Stress Scale (Curry, Campbell, & Christian, 1994; Misra, O'Campo, & Strobino, 2001), and social support using the Medical Outcomes Study Social Support Survey (adapted from Sherbourne & Stewart, 1991). Depression at baseline was measured using the Edinburgh Postnatal Depression Scale. Gestational age at delivery was taken from birth certificates.

Sociodemographic variables included pregnancy intention, maternal education, age, race/ethnicity, whether married or living with a partner, and insurance status measured postpartum. Poverty status was measured using the U.S. Census Bureau classification system incorporating both household income and family composition. Women with household incomes of less than 100% of the poverty threshold are classified as "poor"; those with household incomes between 100% and 200% of the poverty threshold are classified as "near poor"; and those with household incomes at or above 200% of the poverty threshold are classified as "not poor."

Analysis

We conducted statistical analyses using Stata/IC version 11.2 (StataCorp, College Station, TX).

Bivariable analyses

We compared differences in employment, health, and socio-demographic characteristics between those who took leave and those who did not using *t* tests for continuous variables and χ^2 tests for categorical variables. We similarly tested for unadjusted differences in outcomes.

Propensity score analysis

To understand to what extent women who took ANL differed in meaningful ways from women who worked until delivery, and whether this difference consistently related to the probability of taking ANL, we used propensity score matching. This method allows comparison of women with similar observable characteristics that influence the outcomes, but who differ on the likelihood of taking ANL. Having the same distribution of propensity scores in treatment and control groups implies that they have the same distribution of all observed covariates, as if individuals were randomly assigned (Rubin, 2001).

We used the following equation to estimate the probability of taking ANL:

$$p(X_i) = E[ANL_i | \bar{X}_i]$$

where \bar{X}_i is a vector of all covariates that we expected to differ by ANL and that preceded the decision to take ANL during this pregnancy (covariates as listed).

We estimated the probability of ANL (i.e., the propensity score) using logistic regression. We looked for common support and dropped units with propensity scores outside this region. We then used these scores to match treated women (those

taking ANL) with untreated women using radius matching. We tested a range of covariate specifications for estimating the propensity score and radius levels to achieve the best covariate balance in matched samples.

Using matched groups, we used linear probability models to assess the impact of ANL on the likelihood of experiencing a negative delivery outcome. We used Poisson regression to examine the number of negative delivery outcomes because the distribution of outcomes skewed leftward. In all models, we included weights to account for the number of treated units each control observation was matched with (all treated units received a weight of 1). We also included the propensity score as a covariate in addition to other covariates that remained significantly different across treatment groups after matching, or that have been identified in the literature as strong potential confounders (prepregnancy obesity, strong preference for vaginal delivery, perceived stress, employment status, and race/ethnicity). We tested models with and without interactions between ANL and full-time work status and occupation (service or labor vs. professional, managerial, or clerical), separately:

$$Y_{ni} = \alpha + \tau ANL_i + \beta_1 Pscore_i + \beta_2 \bar{X}_i + u_i \quad (1)$$

$$Y_{ni} = \alpha + \tau ANL_i + \beta_1 Pscore_i + \beta_2 \bar{X}_i + \beta_3 ANL_i * FT_i + u_i \quad (2)$$

$$Y_{ni} = \alpha + \tau ANL_i + \beta_1 Pscore_i + \beta_2 \bar{X}_i + \beta_3 ANL_i * occupation_i + u_i \quad (3)$$

where Y_{ni} is outcome n for person i . ANL_i is a dummy variable for whether women stopped working at least 2 days before delivery ($ANL = 1$) versus working until the day before or the day of delivery ($ANL = 0$). τ is the main coefficient of interest in each model. $Pscore_i$ is the estimated probability of ANL for each individual i . \bar{X}_i is a vector of covariates thought to be potential confounders, even after controlling for the propensity score. β_3 in equations (2) and (3) is the coefficient on each interaction.

Multivariable regression analysis with statistical controls

As a comparison, we estimated the relationship between ANL and our outcomes using standard multivariate models in an unmatched sample to statistically control for potential confounders. Potential confounders included all of the variables as described, which were the same as those included in the propensity score analyses. Again, we used linear probability models to examine whether or not women experienced any negative delivery outcome and Poisson regression for the number of negative delivery outcomes. We tested models with and without interactions between ANL and full-time work status.

Sensitivity analyses

We repeated all analyses excluding women who stopped working exactly 2 days before delivery because these women may have stopped working owing to labor beginning and, separately, women who experienced labor longer than 24 hours. We reestimated propensity scores and repeated all analyses among only women who delivered past their due date (i.e., 40 completed weeks or 280 days). We next estimated the duration of ANL relative to women's due date, rather than the actual delivery date, in a subgroup of women who stopped working before their due date and delivered after their due date. With this test, we attempted to identify women who had planned a period of

ANL and were able to take it because they delivered after their due date.

Next, we reestimated propensity scores and repeated all analyses among women who likely quit or were fired during pregnancy. We characterized women who had reported being employed at baseline but no longer employed in the 2 weeks before delivery as having likely quit their jobs or been fired ($n = 829$).

We then repeated all analyses stratified on maternal health, separately estimating propensity scores for healthy and unhealthy women. We characterized as healthy those women who reported no prepregnancy hypertension or diabetes, serious health conditions, or hospitalizations during pregnancy; were not advised by a provider during pregnancy to have a C-section; reported fewer than five doctor office visits in last month of pregnancy; and were not depressed during pregnancy.

To better understand how the duration of ANL impacts negative delivery outcomes, we examined ANL as a categorical variable in standard multivariable regression models. We divided ANL into five categories: no ANL, 2 days, 3 to 6 days, 7 days, and 8 to 30 days. We repeated all traditional multivariable regression analyses using the unmatched sample and this categorical ANL variable.

Results

Descriptive Statistics

One-half of the sample took more than 1 day of leave; 20% took 1 week or more. Among women who took leave, the mean ANL duration was 5.2 days (SD 3.5) and the median ANL was 4 days. Figure 1 shows the distribution of ANL for all employed women in the sample.

Most women (55%) experienced at least one negative delivery outcome (labor induction, labor lasting >24 hours, unplanned C-section, or negative birth experience). Women experienced a mean of 0.82 (SD 0.91) negative outcomes and a maximum of 4 (not shown). Figure 2 shows the distribution of propensity scores

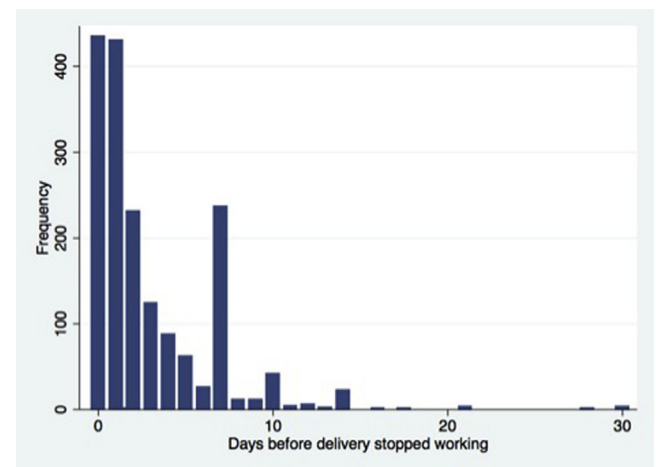


Figure 1. Distribution of antenatal leave (in days) among employed, nulliparous women in Pennsylvania ($n = 1,740$). Includes women who delivered after 36w6d and stopped working fewer than 31 days before delivery.

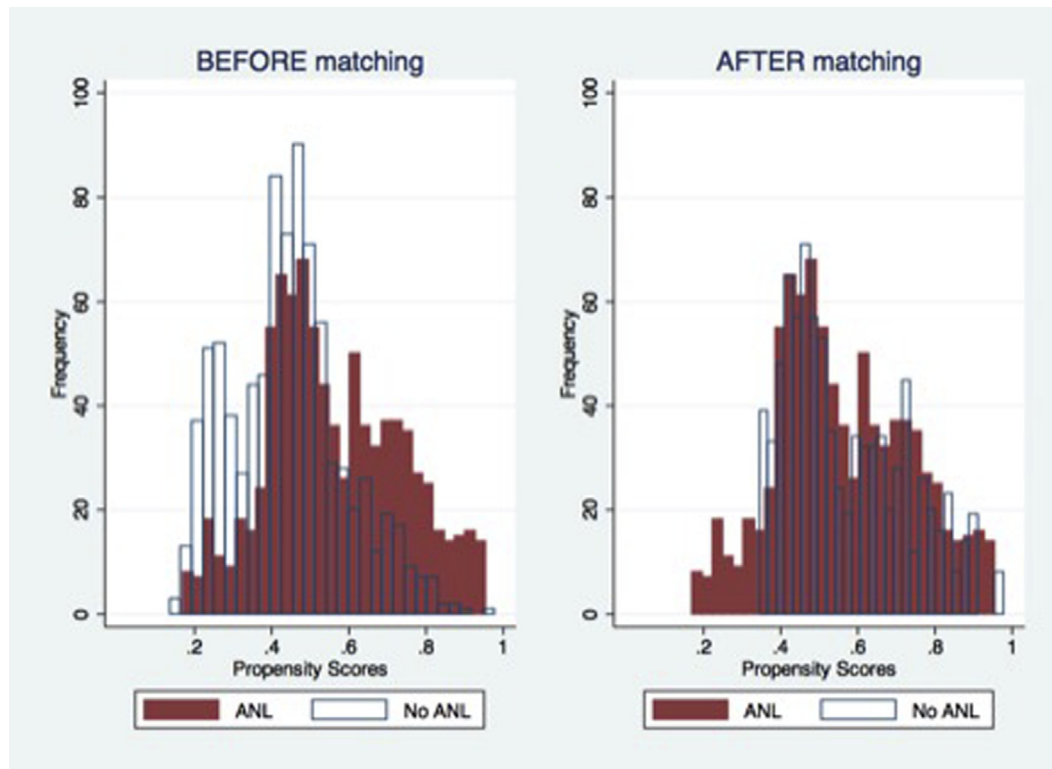


Figure 2. Propensity score distribution by antenatal leave (ANL) before and after matching among employed, nulliparous women in Pennsylvania ($n = 1,740$).

by ANL status before and after matching. The region of common support ranged from 0.17 to 0.96.

Bivariate Analyses

Before matching, women who took ANL differed from those who did not along several dimensions, including hospitalizations during pregnancy, doctor office or urgent care visits, prenatal stress and depression, pregnancy intention, and gestational age at delivery (Table 1). Those who took leave differed on socio-demographic characteristics: they had less education, were younger, were less likely to be non-Hispanic White and more likely to be non-Hispanic Black (no difference in the proportion reporting Hispanic ethnicity), were less likely to be married or living with a partner or privately insured, and were more likely to be near poor than those who did not take leave. They were significantly less likely to be employed full time and more likely to work in service or labor occupations (vs. professional, managerial, or other occupations). After matching, there were no differences between women who took ANL and those who did not along any of these dimensions.

Propensity Score Analysis

Table 2 shows results for linear probability models predicting the likelihood of experiencing a negative delivery outcome (Panel A) and Poisson regression models predicting the number of negative delivery outcomes (Panel B) using the weighted propensity score-matched sample. Column (1) shows unadjusted models; column (2), models adjusted for propensity scores; column (3), models adjusted for propensity scores and additional covariates (prepregnancy obesity, strong preference for vaginal

delivery, perceived stress, employment status, and race/ethnicity); column (4), models with an interaction between employment status and ANL; and column (5), models with an interaction between occupation and ANL. In main effects models, ANL was associated with a 4 to 5 percentage point increase in the likelihood of a negative delivery outcome, although these were all of marginal statistical significance. We detected a significant interaction between ANL and employment status. Women who were employed full-time and took ANL were more likely to experience a negative delivery outcome and women who were employed part time were less likely, but neither relationship attained significance. We detected a significant increase in the number of negative delivery outcomes experienced in our main effects models. Women who took ANL experienced an average of 0.14 more negative outcomes than women who took no ANL ($p < .01$), even after controlling for the propensity score and additional covariates. This represents a 16% increase over the mean of 0.86 negative delivery outcomes. We did not find evidence of an interaction between occupation and ANL with either outcome.

Women who took ANL had a 0.05 increase in the likelihood of experiencing labor lasting longer than 24 hours ($p < .01$) and a 0.06 increase in the likelihood of experiencing an unplanned C-section ($p < .05$; Table 3). These represent a 42% and 25% increases over the means, respectively. Their mean labor duration was 1.21 hours longer ($p < .05$) than women who did not take ANL. There were no significant associations with labor induction or self-reported negative birth experience.

Multivariable Regression Analysis with Statistical Controls

We conducted traditional multivariable linear probability, linear regression, and Poisson regression analyses for negative

Table 1
 Characteristics of the Sample by ANL Status among Employed, Nulliparous Women in Pennsylvania, before and after Matching (n = 1,740)

	Unmatched Sample			Matched Sample		
	ANL	No ANL	p	ANL	No ANL	p
	Mean or %	Mean or %		Mean or %	Mean or %	
Prepregnancy obesity	20%	19%	.67	20%	17%	.12
Gained > recommended	54%	52%	.24	54%	55%	.78
Prior miscarriage	15%	17%	.49	15%	14%	.35
Prepregnancy hypertension or diabetes	4%	3%	.11	4%	3%	.48
Serious health condition during pregnancy	22%	23%	.38	22%	21%	.72
Mean number of hospitalizations	0.18	0.12	.01	0.18	0.16	.29
Number of doctor office or urgent care visits in last month of pregnancy						
0–1	7%	6%	.60	7%	8%	.23
2–4	72%	77%	.01	72%	70%	.42
≥5	21%	17%	.02	21%	21%	.77
Help getting pregnant	11%	14%	.05	11%	10%	.89
Provider advised C-section during pregnancy	8%	6%	.13	8%	7%	.56
Birth Anticipation Scale	16.96	16.54	.05	16.96	16.94	.90
Strong preference for vaginal birth	13%	14%	.60	13%	15%	.14
Maternal stress	18.71	17.79	<.01	18.71	19.07	.12
Low social support	42%	39%	.19	42%	41%	.72
Baseline EPDS	5.98	5.20	<.01	5.98	5.92	.75
Gestational age at delivery						
Early term	15%	30%	<.01	15%	14%	.76
Full term	65%	63%	.41	65%	67%	.31
Late term	19%	6%	<.01	19%	18%	.37
Post term	1%	1%	.09	1%	1%	.84
Full-time employed (vs. part time)	82%	93%	<.01	82%	81%	.53
Service or labor (vs. professional, managerial, or clerical) occupation	33%	27%	<.01	33%	33%	.92
Pregnancy intendedness						
Wanted	71%	77%	.01	71%	70%	.48
Mistimed	28%	22%	<.01	28%	29%	.46
Unwanted	1%	1%	.79	1%	1%	.88
Mother's age at baseline	27.82	28.83	<.01	27.82	27.72	.60
Maternal education						
High school graduate or less	10%	6%	<.01	10%	13%	.17
Some college or vocational programs	24%	23%	.38	24%	23%	.55
College grad	65%	71%	.01	65%	64%	.70
Maternal race/ethnicity						
Hispanic	3%	2%	.40	3%	3%	.51
Non-Hispanic White	90%	93%	.01	90%	89%	.45
Non-Hispanic Black or Other	7%	4%	.02	7%	9%	.21
Unmarried or not living with partner (vs. married or living with partner)	8%	4%	<.01	8%	10%	.16
Public insurance (vs. private or OOP)	13%	5%	<.01	13%	12%	.38
Poverty status						
Poor	4%	3%	.06	4%	5%	.35
Near poor	8%	3%	<.01	8%	8%	.94
Not poor	87%	94%	<.01	87%	86%	.60

Abbreviations: ANL, antenatal leave; EPDS, Edinburgh Postnatal Depression Scale; OOP, out of pocket.

Note: *p*-values from *t* tests. Serious health condition defined as hypertension, high blood pressure, or preeclampsia that started during pregnancy; diabetes that started during pregnancy; vaginal bleeding; early or preterm labor; and bed rest or hospitalization because of premature labor. The First Baby Study Birth Anticipation Scale measures fear of childbirth. Maternal stress measured with the Perceived Stress Scale. Early term refers to gestations of 37w0d to 38w6d; full term refers to 39w0d to 40w6d, late term refers to 41w0d to 41w6d, and post term refers to >42w0d. We excluded preterm deliveries (i.e., <37w0d) from the sample. Poverty status was measured using the U.S. Census Bureau classification system incorporating both household income and family composition. Women with household incomes <100% of the poverty threshold are classified as “poor”; those with household incomes between 100% and 200% of the poverty threshold are classified as “near poor”; and those with household incomes ≥200% of the poverty threshold are classified as “not poor.” In matched models, we matched women who took ANL with one or more women who did not take ANL on estimated propensity scores within a 0.04 caliper radius.

delivery outcomes (any and count), labor induction, labor duration, unplanned C-section, and self-reported negative birth experience in the unmatched sample, adjusting for all of the covariates used to estimate the propensity score. Coefficients from these models were similar in magnitude and significance to the results from propensity score analyses, although the interaction between ANL and employment status was no longer significant (Table 4).

Sensitivity Analyses

Excluding women who stopped working exactly 2 days before delivery and women who experienced labor longer than 24 hours

did not change our results (data not shown). Reestimating propensity scores and repeating analyses among only women who delivered past their due date (i.e., 40 completed weeks gestation or 280 days) did not change our results, nor did estimating the duration of ANL relative to women's due date, rather than her actual delivery date, in the subgroup of women who stopped working before their due date and who delivered after their due date. Results for women who quit or were fired during pregnancy were comparable with the results for women who took ANL (data not shown).

We repeated all analyses stratified on maternal health (Table 5). Among healthy women, ANL did not increase the likelihood of any negative delivery outcome or increase the mean

Table 2
Multivariable Linear Probability and Poisson Regression Results in Propensity-Score Matched Groups (N = 1,740)

	(1)	(2)	(3)	(4)	(5)
	Coeff. (95% CI)	Coeff. (95% CI)	Coeff. (95% CI)	Coeff. (95% CI)	Coeff. (95% CI)
A: Any negative delivery outcome					
ANL (≥ 2 days)	0.04 (–0.00 to 0.09)	0.05 (0.00–0.09)*	0.04 (–0.00 to 0.09)	–0.06 (–0.17 to 0.05)	0.05 (–0.01 to 0.10)
Full-time employed				0.01 (–0.08 to 0.10)	
Full-time employed \times ANL (≥ 2 d)				0.13 (0.01–0.24)*	
Service or labor occupation					–0.06 (–0.13 to 0.01)
Service or labor \times ANL (≥ 2 d)					–0.02 (–0.12 to 0.08)
Propensity score	N	Y	Y	Y	Y
Additional covariates	N	N	Y	Y	Y
Full-time work interaction	N	N	N	Y	N
Service or labor interaction	N	N	N	N	Y
Mean of negative delivery outcomes	0.58	0.58	0.58	0.58	0.58
Weighted observations	1747	1747	1747	1747	1747
R ² /pseudo R ²	0.00	0.03	0.04	0.04	0.04
B: Number of negative delivery outcomes					
ANL (≥ 2 days)	0.15 (0.04–0.25) [†]	0.15 (0.05–0.25) [†]	0.14 (0.03–0.24) [†]	0.14 (–0.10 to 0.38)	0.13 (0.00–0.25)*
Full-time employed				0.23 (0.02–0.44)*	
Full-time employed \times ANL (≥ 2 days)				0 (–0.27 to 0.27)	
Service or labor occupation					–0.13 (–0.30 to 0.04)
Service or labor \times ANL (≥ 2 days)					0.04 (–0.18 to 0.26)
Propensity score	N	Y	Y	Y	Y
Additional covariates	N	N	Y	Y	Y
Full-time work interaction	N	N	N	Y	N
Service or labor interaction	N	N	N	N	Y
Mean of negative delivery outcomes	0.86	0.86	0.86	0.86	0.86
Weighted observations	1747	1747	1747	1747	1747
R ² /pseudo R ²	0.00	0.01	0.02	0.02	0.02

Abbreviations: ANL, antenatal leave; CI, confidence interval.

Note: Coefficients and 95% CIs for linear probability models (Panel A) and linear regression models (Panel B). All models are weighted to account for the number of units each observation was matched with. Column (1) shows unadjusted models; column (2) shows models adjusted for propensity scores; column (3) shows models adjusted for propensity scores and additional covariates (prepregnancy obesity, strong preference for vaginal delivery, perceived stress, employment status, and race/ethnicity); column (4) shows models that include an interaction between employment status and ANL, and column (5) shows models that include an interaction between occupation and ANL. Occupation is categorized as service or labor versus professional, managerial, or clerical. Negative delivery outcomes include labor induction, labor lasting >24 hours, unplanned C-section, and self-reported negative birth experience.

* Significant at 5%.

[†] Significant at 1%.

duration of labor. Among unhealthy women, all coefficients increased, although smaller sample sizes prevent detection of statistical significance in some models. Unhealthy women who took ANL had a 10 percentage point increase in the likelihood of experiencing any negative delivery outcome ($p < .01$) and experienced 0.26 more negative outcomes ($p < .01$) than unhealthy women who did not take ANL. Unhealthy women who took ANL were marginally more likely to experience long labor duration ($p < .10$) and experienced an 11 percentage point increase in the likelihood of an unplanned C-section ($p < .01$).

Finally, we examined ANL as a categorical variable in standard multivariable regression models (Appendix Table A1). These results suggest that relatively long ANL (>1 week) did not drive the observed associations. ANL longer than 1 week was not associated significantly with any outcome after adjusting for covariates. Similarly, very short ANL does not seem to drive the results, with the notable exception of labor duration. Women who took 2 days of ANL reported significantly longer labor duration than women who took no ANL, but this could reflect women stopping working because they were in labor, rather than taking ANL before labor began. We also observed significantly longer labor duration among women who took three to six days ANL. Because labor lasting longer than 48 hours occurred in less than 1% of the sample, ANL likely preceded labor in this group. Women who stopped working 3 to 6 days before delivery were significantly more likely to experience any negative delivery outcome, labor longer than 24 hours, or unplanned C-section, and they experienced more negative delivery outcomes

overall. Women who stopped working 1 week before delivery were significantly more likely to have been induced and experienced more negative delivery outcomes.

Discussion

In this sample of nulliparous employed women in Pennsylvania who delivered at term, women who took ANL experienced more negative delivery outcomes than women who took no leave. In particular, women who took ANL were significantly more likely to have an unplanned C-section and to have long labor duration. Our robust results held up to a range of sensitivity analyses.

Our results provide evidence for an adverse selection pathway linking ANL to unhealthy maternal health status. Although we could not detect a protective pathway, our findings suggest that ANL does not harm delivery outcomes of healthy women. Additional evidence for ongoing adverse selection comes from sensitivity analyses comparing women who quit or were fired with women who did not take any ANL. These analyses yielded similar results to the main findings, indicating that women who take ANL and women who quit or were fired share characteristics that lead to negative delivery outcomes—likely unmeasured prenatal health conditions and/or psychologically or physically demanding jobs. Stratifying on maternal health further illuminated ongoing adverse selection. Notably, analyses including only healthy women yielded no significant associations, whereas the strength of a negative association between

Table 3
Multivariable Linear Probability and Linear Regression Results in Propensity-Score Matched Groups (N = 1,740)

	Labor Induced	Labor >24 hours	Hours in Labor	Unplanned C-section	Negative Birth Experience
	Coeff. (95% CI)	Coeff. (95% CI)	Coeff. (95% CI)	Coeff. (95% CI)	Coeff. (95% CI)
Panel A: Main effects only					
ANL (≥2 days)	0.02 (−0.03 to 0.06)	0.05 (0.02–0.08) [†]	1.21 (0.25–2.16) [*]	0.06 (0.02–0.10) [†]	0.02 (−0.02 to 0.06)
Propensity score	Y	Y	Y	Y	Y
Additional covariates	Y	Y	Y	Y	Y
Mean of outcome	0.33	0.12	14.54	0.24	0.19
Weighted observations	1747	1618	1618	1648	1739
R ² /pseudo R ²	0.06	0.01	0.01	0.03	0.02
Panel B: Full-time work interaction					
ANL (≥2 days)	−0.02 (−0.12 to 0.08)	0.03 (−0.05 to 0.10)	0.97 (−1.33 to 3.26)	0.04 (−0.06 to 0.13)	0.09 (0.00–0.18) [*]
Full-time employed	0.08 (−0.01 to 0.16)	0.03 (−0.03 to 0.10)	2.39 (0.45–4.32) [*]	0.05 (−0.03 to 0.13)	0.04 (−0.03 to 0.12)
Full-time employed × ANL (≥2 days)	0.05 (−0.07 to 0.16)	0.02 (−0.06 to 0.11)	0.29 (−2.24 to 2.83)	0.03 (−0.08 to 0.14)	−0.09 (−0.19 to 0.01)
Propensity score	Y	Y	Y	Y	Y
Additional covariates	Y	Y	Y	Y	Y
Mean of outcome	0.33	0.12	14.54	0.24	0.19
Weighted observations	1747	1618	1618	1648	1739
R ² /pseudo R ²	0.06	0.01	0.01	0.03	0.03

Abbreviations: CI, confidence interval; ANL, antenatal leave.

Note: Coefficients and 95% confidence intervals for linear probability models (labor induction, long labor duration, unplanned C-section, and negative birth experience) and linear regression models (hours in labor). Panel A includes only main effects; Panel B includes an interaction between ANL and full-time employment. All models are weighted to account for the number of units each observation was matched with. Additional covariates include prepregnancy obesity, strong preference for vaginal delivery, perceived stress, employment status, and race/ethnicity.

* significant at 5%.

† significant at 1%.

ANL and maternal health increased when limited to relatively unhealthy women.

Our findings do not imply that ANL is not protective, but strong selection, as well as the U.S. policy context, precluded us from detecting a protective effect. This could be because we selected a relatively healthy sample of women overall: those who delivered at term and who continued working into their last month of pregnancy. Additionally, women in our sample took relatively short leaves (the mean duration among women who took any ANL was 5 days), potentially limiting the observable benefit of ANL. This differs markedly from France, for example,

where all employed women are offered at least 6 weeks of paid maternity leave before delivery and employers are not allowed to employ or engage pregnant workers 2 weeks before delivery (Vigoureux, Blondel, Ringa, & Saurel-Cubizolles, 2016). In that context, only 1.2% of employed women who gave birth after 36 completed weeks gestation continued working until the week they delivered (Vigoureux et al., 2016). Like our study, this French study found that women with pregnancy complications were less likely to take “late” ANL (at or after 37 weeks’ gestation), but that late ANL was not associated with unfavorable labor or perinatal outcomes (Vigoureux et al., 2016).

Table 4
Multivariable Linear Probability, Linear Regression, and Poisson Regression Results in Unmatched Groups (N = 1,740)

	Any Negative Delivery Outcome	Number of Negative Delivery Outcomes	Labor Induced	Labor >24 Hours	Labor Duration	Unplanned C-section	Negative Birth Experience
	Coeff. (95% CI)	Coeff. (95% CI)	Coeff. (95% CI)	Coeff. (95% CI)	Coeff. (95% CI)	Coeff. (95% CI)	Coeff. (95% CI)
ANL (≥2 d)	0.06 (0.01–0.11) [*]	0.16 (0.04–0.27) [†]	0.03 (−0.01 to 0.08)	0.04 (0.01–0.08) [†]	1.39 (0.40–2.39) [†]	0.06 (0.02–0.10) [†]	0.01 (−0.03 to 0.05)
Mean of outcome	0.55	0.82	0.31	0.11	14.20	0.24	0.19
Observations	1740	1740	1740	1606	1606	1635	1730
R ² /pseudo R ²	0.10	0.04	0.11	0.03	0.04	0.07	0.10

Abbreviations: ANL, antenatal leave; CI, confidence interval.

Note: All models control for prepregnancy obesity; whether the woman gained more weight than recommended during pregnancy; prior miscarriage; self-reported history of diabetes or hypertension before pregnancy; presence of medical problems during current pregnancy (hypertension, high blood pressure, or preeclampsia that started during pregnancy; diabetes that started during pregnancy; vaginal bleeding; early or preterm labor; bed rest or hospitalization because of premature labor); number of hospitalizations during pregnancy; number of doctor office or urgent care visits in the last month of pregnancy; whether woman received help getting pregnant; whether a provider advised a C-section during pregnancy; fear of childbirth measured with the First Baby Study Birth Anticipation Scale (BAS); strong preference for vaginal delivery; prenatal stress using Perceived Stress Scale; social support; baseline EPDS; gestational age at delivery; pregnancy intention; maternal education; maternal age and age squared; race/ethnicity; whether married or living with partner; insurance and poverty status. Serious health condition defined as hypertension, high blood pressure, or preeclampsia that started during pregnancy; diabetes that started during pregnancy; vaginal bleeding; early or preterm labor; bed rest or hospitalization because of premature labor. The First Baby Study Birth Anticipation Scale (BAS) measures fear of childbirth. Maternal stress measured with the Perceived Stress Scale. Early term refers to gestations of 37w0d to 38w6d; full term refers to 39w0d to 40w6d, late term refers to 41w0d to 41w6d, and post term refers to >42w0d. We excluded preterm deliveries (i.e., <37w0d) from the sample. Poverty status was measured using the US Census Bureau classification system incorporating both household income and family composition. Women with household incomes <100% of the poverty threshold are classified as “poor”; those with household incomes between 100–200% of the poverty threshold are classified as “near poor”; and those with household incomes at or above 200% of the poverty threshold are classified as “not poor.” Negative delivery outcomes include labor induction, labor lasting more than 24 hours, unplanned C-section, and self-reported negative birth experience.

* significant at 5%.

† significant at 1%.

Table 5 Sensitivity Analysis, by Maternal Health, Multivariable Linear Probability, Linear Regression, and Poisson Regression Results in Propensity-Score Matched Groups (N = 1,740)

	Any Negative Delivery Outcome		Number of Negative Delivery Outcomes		Labor Induced		Labor >24 Hours		Hours in Labor		Unplanned C-Section		Negative Birth Experience	
	Coef.	(95% CI)	Coef.	(95% CI)	Coef.	(95% CI)	Coef.	(95% CI)	Coef.	(95% CI)	Coef.	(95% CI)	Coef.	(95% CI)
Panel A: Healthy women														
ANL (≥ 2 days)	0.02	(-0.04 to 0.09)	0.07	(-0.09 to 0.23)	0.02	(-0.03 to 0.08)	0.03	(-0.01 to 0.07)	0.79	(-0.43 to 2.01)	0.02	(-0.03 to 0.08)	-0.01	(-0.06 to 0.04)
Mean of outcome	0.50		0.71		0.25		0.10		13.76		0.21		0.17	
Weighted observations	945		945		945		893		893		908		940	
R ² /pseudo R ²	0.10		0.04		0.11		0.02		0.03		0.04		0.04	
Panel B: Unhealthy women														
ANL (≥ 2 days)	0.10	(0.03–0.16) [†]	0.26	(0.11–0.41) [†]	0.06	(-0.01 to 0.12)	0.05	(-0.00 to 0.10)	1.47	(-0.05 to 2.99)	0.11	(0.05–0.17) [†]	0.04	(-0.01 to 0.10)
Mean of outcome	0.61		0.92		0.34		0.13		14.85		0.26		0.22	
Weighted observations	868		868		868		781		781		798		865	
R ² /pseudo R ²	0.06		0.03		0.08		0.02		0.02		0.06		0.07	

Abbreviations: ANL, antenatal leave; CI, confidence interval.

Note: Coefficients and 95% CIs for linear probability models (any negative delivery outcome, labor induction, long labor duration, unplanned C-section, and negative birth experience), Poisson regression (number of negative delivery outcomes), and linear regression models (hours in labor). Panel A (healthy women) includes only women who reported no pre-pregnancy hypertension or diabetes, serious health conditions, or hospitalizations during pregnancy; were not advised by a provider during pregnancy to have a C-section; reported <5 doctor office visits in last month of pregnancy; and were not depressed during pregnancy. Panel B (unhealthy women) includes only women with at least one of those conditions. All models are weighted to account for the number of units each observation was matched with and adjust for the propensity score, pre-pregnancy obesity, strong preference for vaginal delivery, perceived stress, gestational age at delivery, employment status, maternal age, (maternal age)², and race/ethnicity. Negative delivery outcomes include labor induction, labor lasting more than 24 hours, unplanned C-section, and self-reported negative birth experience.

[†] Significant at 1%.

Like all but a few U.S. states, Pennsylvania has no paid maternity leave law. Eligible Pennsylvania women who wish to stop working during pregnancy can take advantage of the federal Family and Medical Leave Act, which provides up to 12 weeks of unpaid leave for, among other things, one's own illness. Women may choose not to use this leave for two reasons: it is entirely unpaid and using it during pregnancy reduces the amount of leave available after childbirth. Pennsylvania women may take ANL through temporary disability programs, where available, which, through the Pregnancy Discrimination Act must provide the same leave for a woman on maternity leave or disabled by pregnancy as would be provided for other temporary disabilities. Five states (California, Hawaii, New Jersey, New York, Rhode Island) and Puerto Rico have temporary disability insurance laws that provide income replacement to employees on leave. One recent study linked these leave policies to reductions in low birth weight and early term (<39 weeks' gestation) birth (Stearns, 2015). Pennsylvania has no such state law, although individual employers may offer relevant benefits. With limited options for taking leave during (and after) pregnancy, women in Pennsylvania may only take ANL when medically necessary, as the results of this study imply. They do not seem to take leave because it might be good for their health and well-being, or to help them approach childbirth feeling more relaxed and less fatigued.

Our study benefits from a rich dataset with extensive questions on pregnancy, labor and delivery, and postpartum. Propensity scores facilitated exploitation of this detailed information. Still, the narrow set of employment characteristics limits our ability to remove bias. Furthermore, we cannot determine the reason women took leave and whether they intended the amount of leave they took. Some women may have delivered too soon to take the leave they had planned or took leave because they delivered later than expected. This study can only address the leave women took and cannot fully capture whether women planned their ANL. For example, a woman who worked until Friday and delivered on Monday would be categorized as having taken ANL, even though she may not have taken any formal, planned leave from work. We did not hold any a priori hypotheses about whether planned leave should matter more than unplanned leave in terms of allowing women time to rest and prepare for labor; however, future work should examine this question directly by asking women about planned leave, as well as actual leave taken.

The FBS includes a diverse sample of nulliparous women in Pennsylvania, although women in this sample were slightly older and more likely to be White, to be more educated, to have private insurance, and to be married than women in the state overall. Results cannot necessarily be generalized to multiparous women, nor to nulliparas nationally, although Pennsylvania's lack of ANL offerings compares to that of all but a handful of U.S. states.

Implications for Practice and/or Policy

Not finding support for a protective effect of ANL does not imply that pregnant women should be encouraged to work until delivery or that laws and policies allowing leave do not help. In fact, the strong selection into ANL in this sample of Pennsylvania women suggests that women who take leave suffer from particularly difficult pregnancies or jobs and could benefit from expanded availability of leave. Many women in the United States do not have access to paid, job-protected leave and thus must forgo income or possibly risk their jobs by taking ANL. We found

an association of ANL with negative delivery outcomes, plausibly reflecting selection into ANL by women who had to take leave, rather than women who took leave for protective reasons (i.e., to rest and prepare for delivery).

Although the results of this study need to be replicated, they suggest that women's ANL experience provides clues about risks of complications during labor and delivery. Clinicians and others who work with pregnant women should understand women's work environment during pregnancy, including if and when they stopped working. Prenatal health care providers also have a role to play in informing pregnant women of their rights regarding maternity leave, antenatally and postnatally, where applicable.

Supplementary Data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.whi.2016.09.006>.

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