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Prenatal Care and Subsequent Birth Intervals

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Abstract

Context—Research on the effectiveness of prenatal care has focused primarily on birth outcomes, finding small effects at the population level. However, prenatal care generally includes postpartum contraceptive and health education that may enable women to better control their subsequent fertility. Associations between prenatal care and subsequent fertility have not been previously explored.

Methods—Using longitudinally-linked birth records from New Jersey between 1996 and 2006, we estimated multinomial logistic regression models to investigate associations between prenatal care (timing or adequacy) in a mother's first birth and timing of her second birth, controlling for sociodemographic characteristics and hospital and year of birth.

Results—Most mothers initiated prenatal care in the first (85%) or second (12%) trimester. Initiation of care after the first trimester is strongly associated with short subsequent birth intervals. The odds of having a second child in fewer than 18 months (compared to 18–59 months) were 19% higher if the mother initiated care in the second versus the first trimester, 26% higher if she initiated care in the third trimester, and 61% higher if she did not receive any care, all else equal. The associations are robust to alternative measures of prenatal care and birth intervals and are stronger for mothers with low levels of education.

Conclusions—The findings suggest that prenatal providers should capitalize on their limited encounters with mothers who initiate prenatal care late or use it sporadically to make information about family planning available. This issue is timely given recent and proposed budget cuts to public family planning.

Introduction

The proportion of births in the United States taking place within 2 years of a previous birth increased from 11 to 18% between 1995 and 2002.[1] The reasons for this dramatic increase have not, to our knowledge, been explored. A recent meta-analysis indicates that short and long inter-pregnancy intervals (time between a birth and the mother's subsequent conception) are associated with adverse perinatal outcomes including preterm birth, low birthweight, and small for gestational age,[2] which in turn are associated with a number of health and developmental conditions in childhood.[3] This patchwork literature uses

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inconsistent cutoffs denoting both long and short birth intervals. A very recent study found that short inter-pregnancy intervals (defined as less than 12 months) are strongly associated with autism and that the association was not mediated by low birthweight or preterm birth, suggesting that there may be other pathways.[4] Proposed mechanisms by which short inter-pregnancy intervals lead to adverse infant outcomes involve maternal nutritional depletion, particularly folate.[2] Hypothesized mechanisms relating long birth intervals to adverse maternal and child health outcomes are even less developed.[2]

Prenatal care is one of the most frequently used health services in the United States.[5,6] As part of standard prenatal care, which involves a series of encounters during pregnancy, providers educate women about pregnancy, monitor medical conditions (such as high blood pressure), test for gestational health problems (such as gestational diabetes), and refer expectant mothers to services such as the Special Supplemental Nutrition Program for Women, Infants, and Children and family planning resources.[7] The recommendation over the past several decades has been for prenatal care to begin as early as possible during pregnancy, or ideally, prior to conception.[8] Owing largely to expansions of Medicaid for pregnant women in the late 1980s and early 1990s, prenatal care has become quasi-universal in the US, with 92–96 percent of mothers giving birth in 2006 receiving at least some prenatal care.9[a] However, there is variation in the timing and adequacy of that care. For example, 17% of births in the US in 2006 were to mothers who initiated care after the first trimester[9] and about 25% of births in the US in 2002 were to mothers who had less than adequate prenatal care as defined by the Adequacy of Prenatal Care Utilization Index,[10] which takes into consideration both timing of initiation of care and number of visits conditional on the infant's gestational age at delivery.[b] An explicit goal of Healthy People 2010 was to increase the proportion of pregnant women who receive early and adequate prenatal care.[11]

Most research on the effectiveness of prenatal care has focused on infant health outcomes (typically birthweight or infant mortality) and has tended to find very modest or no effects.[12,13] Some recent studies have taken a broader view of the potential of prenatal care, recognizing that providing pregnant women with health information and counseling (e.g., about nutrition and the risks of substance use)—a typical component of prenatal care—may improve health behaviors and health after the child is born. Indeed, the broad goal of contemporary prenatal care is to promote the health of the mother, child, and family through the pregnancy, delivery, and the child's development.[8] There is some evidence that prenatal services improve maternal postpartum health behaviors. One randomized controlled study found that prenatal breastfeeding education and counseling increased rates of breastfeeding among urban black low-income women,[14] and another recent study using econometric techniques to address potential omitted variables bias found that first trimester prenatal care decreases maternal postpartum smoking and appears to increase breastfeeding.[15]

As far as we know, the role of standard prenatal care, which is quasi-universal and includes family planning and other health education components, in shaping future reproductive behaviors has not previously been studied. It seems plausible that it could affect subsequent birth spacing through fertility control. According to a recent study using 2004–2005 Prenatal Risk Assessment Monitoring System (PRAMS) data from Florida, 80 percent of mothers reported that, during the course of their prenatal care, a health care worker talked to them about postpartum birth control use.[16] This figure is identical to a 2006 aggregate estimate

[a]The range reflects different question wording on the two different versions of the US Standard Certificate of Live Birth that were in use by states at that time (most states, including New Jersey, still used the 1989 form, but some had transitioned to the 2003 revised form). The revised form has not yet been validated.

[b]Figures are based on the 1989 version of the US Standard Certificate of Live Birth.

from 24 PRAMS sites produced for the authors by Division of Reproductive Health of the Centers for Disease Control and Prevention.[17] Data from the Guttmacher Institute suggest that public funding of family planning programs in the US. is effective in preventing unintended pregnancies[18] and abortions.[19] The evidence on clinical interventions to prevent unintended pregnancy and improve adherence to contraceptives is mixed, however, although that literature is fraught with methodological issues such as small sample sizes, attrition, and weak interventions.[20,21] Prenatal care could also affect subsequent birth intervals by encouraging breastfeeding (as discussed above), which is associated with reduced fecundity.[22]

Prenatal care may increase fertility control by providing family planning and health education, which may empower women and lead to family planning more consistent with lifestyle preferences and values, increased contraceptive efficacy, and perhaps decisions not to go through with unplanned pregnancies. A great deal of literature has shown that fertility is inversely related to women's education in developing countries, that women's reproductive behavior is strongly influenced by the levels of economic development and gender inequality in a society, and that the impact of education on fertility depends on women's autonomy.[23,24] There has been tremendous interest, particularly since the International Conference on Population and Development in Cairo and 4th World Conference on Women in Beijing, in non-formal education programs designed to educate and empower women on family planning in developing countries, with convincing evidence that such programs affect reproductive behavior.[24] While there has been scant population-based research on the effects of reproductive health education on fertility in developed countries, it is possible that education that takes place as part of prenatal care empowers women to control their fertility even in those contexts. That is, it is possible that the underlying issues of population and development in the third world, such as education, gender inequality, and poverty, are relevant—at least to some extent—in developed countries.

Prenatal care may also increase fertility control by connecting mothers to medical and social service systems, some for the first time. Studies have found that children whose mothers had early or adequate prenatal care are more likely than those whose mothers had inadequate or late care to have recommended numbers of well-child visits and adequate immunizations, controlling for income and other measures of socioeconomic status.[25,26] Another used econometric techniques to address potential omitted variables bias and had similar findings vis-à-vis well-child visits.[15] Connection to the health care system may provide access to, and encourage the use of, family planning services.

Finding that prenatal care affects subsequent birth spacing and understanding the underlying pathways would call for a re-examination of the role and content of prenatal care. Given that half of all births in the United States are unintended,[27] the potential for prenatal care to play a role in shaping future fertility appears to be substantial. In this study, we take the necessary first steps in investigating this issue by establishing whether there is an association, and possible causal relation, between exposure to prenatal care and subsequent birth intervals and assessing whether the relative associations for different groups of mothers are consistent with our conceptualization of how prenatal care would affect fertility. We hypothesize that (1) increased exposure to prenatal care increases fertility control and leads to decreases in short subsequent birth intervals; (2) the effects of prenatal care on long birth intervals are much weaker than those on short birth intervals, since family planning messages during prenatal care should affect behavior more in the postpartum period than in the long term; and (3) the effects of prenatal care are strongest for women with low educational attainment, who stand to gain the most from prenatal health information.

Methods

Sample

We linked Electronic Birth Certificate (EBC) files from the state of New Jersey longitudinally across births to the same mother. Such files are increasingly being compiled by states, but have typically been used to compare birth outcomes across pregnancies. The linked file includes records for approximately one million live births that took place in the state of New Jersey from 1996 to 2006. New Jersey used the 1989 version of the US Standard Certificate of Live Birth throughout this period; that is, like most other states, it had not adopted the revised 2003 form. In the data collection for the EBC, the standard birth certificate fields were augmented with additional variables of interest to the state.

The EBC files contained mother identifiers and date of last live birth, which allowed us to conduct the longitudinal matching of in-state births to the same mother during the 1996–2006 observation period. For the 76% of the records that indicated a date of last live birth after 1/1/96, the previous birth records were found. The other 24% of births were to mothers who either gave birth in another state or did not match for other reasons (these cannot be disentangled using this file alone). As would be expected, the match rate was highest for women who themselves were born in New Jersey (82%) and much lower for mothers who were foreign-born (63%).[c] The longitudinal linkage process is described in more detail in Denk and Kruse.[28] The EBC files contained data on the timing and use of prenatal care, demographics, and other characteristics that are routinely available in natality files, as well as the date and hospital of birth. They also include information on Medicaid coverage for the birth.

We restricted our analysis to women who had a first birth between 1996 and 2000. Of those 208,142 women, we identified 130,919 who had at least one other birth in NJ within the study period. After removing cases with missing records on intermediate births, the sample was reduced to 126,360 mothers. We further restricted the sample to the 125,140 mothers whose first and second births were both singleton births. Data errors (231 women with shorter birth intervals than the gestation of the second child) and missing data on analysis variables (11,247 observations, or 9%) further reduced our sample to 113,662 mothers.

The 9% included 4407 cases (3.5% of the 125,140) that had missing data on Medicaid, an additional 4059 cases (3.2%) that had missing data on month of prenatal care initiation, and another 2781 cases (2.2%) that had missing data on one or more of the following: education, Hispanic origin, nativity, marital status, and information needed to construct an index of prenatal care adequacy (described later)—namely, gestational age and number of prenatal visits. While the proportion of the sample with missing data on any one measure is small, the pattern of sample loss due to missing data is not random. Missing data were more common among mothers with short and long birth intervals, who were teens, who were non-Hispanic black, and who were unmarried at the time of the first birth.

Measures

Our primary outcome measure was length of time between the mother’s first and second births, categorized as < 18 months, 18–59 months, and >= 60 months. Although inter-pregnancy intervals would better capture reproductive behavior subsequent to prenatal care, we focus primarily on birth intervals because we do not have data on second pregnancies that did not result in live births (that is, those that ended in miscarriages or induced

[c]It is important to note, however, that the reported match rates are based on the proportion of parity two births in New Jersey that match to first births in New Jersey, and not from first to second births. The match rate is likely to be much higher for immigrants when the sample is restricted to first births that occurred in New Jersey as we do in our analyses.

abortions). That said, in supplementary models we consider inter-pregnancy intervals, calculated as the birth interval minus the second child's gestational age, a formula used frequently in studies cited earlier[2,4] that is equivalent to the interval from the date of birth of the first child to the estimated date of conception of the second child. In our sample of live births, the average difference between the woman's birth interval and her inter-pregnancy interval is 8.96 months (that figure is equivalent to the gestational age of the second child). Since the existing literature uses inconsistent cutoffs for long or short intervals, we assessed the sensitivity of our estimates to alternative birth interval and inter-pregnancy interval cutoffs.

Our main measure of exposure to prenatal care was a categorical variable characterizing whether the mother's first prenatal visit took place during the first 3 months of the pregnancy corresponding to her first birth, during months 4 to 6 of the pregnancy, after the sixth month of the pregnancy, or not at all, with 1 to 3 months as the reference category. According to the coding instructions for the New Jersey EBC, a prenatal care visit is defined as a visit with a health professional specifically related to the current pregnancy, including visits for physical examination, history, counseling, and/or treatment. An alternative measure of exposure to prenatal care was the Graduated Index (GINDEX-revised), which takes into consideration both the month of prenatal care initiation and the number of prenatal care visits compared to the ACOG- recommended number given the infant's gestational age at delivery. The GINDEX-revised categorizes care as inadequate, intermediate, adequate, intensive (attempting to capture high risk pregnancies), missing, or no care (see Alexander and Kotelchuck[29] for a review of different measures of adequacy of prenatal care).

Control variables, all measured at the time of the first birth, included the mother's age (less than 20 years, 20–34 and 35 year and over, with 20–34 as the reference category), race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and other, with non-Hispanic white as the reference category), nativity (foreign born, as opposed to US born), education (less than 12 years, 12–15 years, and 16+ years, with 16+ years as the reference category), a variable characterizing marital status and father involvement (married with father information in the birth record and unmarried with father information in the birth record, with lacking father information--whether married or unmarried—as the reference category), and whether the birth was financed by Medicaid (as a proxy for poverty) as opposed to any other source. Additionally, to control for unobserved factors that may vary by hospital and over time, we included indicators for hospital and year of first birth.

Analysis

First, we present sample characteristics by trimester of care initiation. Then we present subsequent birth intervals by timing of prenatal care initiation, prenatal care adequacy as characterized by the GINDEX-revised, and maternal characteristics. In both descriptive tables, we present results from chi squared tests of equal proportions to identify significant differences across groups. Finally, we present a series of multivariate analyses based on multinomial logistic regression with robust standard errors to account for clustering at the hospital level. For each model, we present results from tests of statistical significance for the multinomial regression estimates as well as McFadden's pseudo R-squared statistic for model fit.

In the multivariate analyses, we are interested in the associations between prenatal care during a first pregnancy and the timing of the mother's second birth (and in supplementary analysis, described later, on subsequent inter-pregnancy interval), controlling for other factors that may be associated with both prenatal care timing and subsequent birth spacing. Mothers in our sample were not equally exposed to the risk of having long birth intervals. Those having their first births in 1996, at the very beginning of our observation period, were

observed for 10–11 years whereas mothers having their first births at the end of our time frame were observed for only 6–7 years. However, the indicators for year of first birth adjust for unequal exposure. We also verified that, in our data, most second births took place within the lower-bound 6–7 year exposure interval. Specifically, 89% of mothers who first gave birth in 1996, a group observed for 10–11 years, had their second birth within the next 6 years.

We used multinomial logistic regression models to estimate associations between prenatal care (separately using timing of initiation and the GINDEX-revised) and subsequent birth interval, net of sociodemographic characteristics and controlling for hospital and year of birth. We also conducted analyses stratified by maternal education (< 12 years, 12+ years), with the sample limited to mothers at least 25 years old to minimize potential confounding between maternal education and age. Finally, we conducted a set of supplementary analyses to explore the sensitivity and robustness of our findings.

As discussed earlier, prenatal care could affect birth spacing through family planning (increasing use of contraception) or breastfeeding (reducing fecundity). We therefore expected that early and adequate prenatal care would reduce the prevalence of short birth intervals (<18 months) and have less of an impact on long intervals (>=60 months); our multinomial logistic regression models of the effects of prenatal care timing and adequacy allow us to test this hypothesis. We also expected that less-educated mothers would be more influenced by health education and family planning messages imparted during the course prenatal care; our analyses stratified by maternal education allow us to test that hypothesis.

Results

Eighty five percent of the mothers initiated care in the first trimester of pregnancy, 12 percent initiated care in the second trimester, 3 percent initiated care in the third trimester, and less than one percent had no care at all. The composition of early initiators differs from that of later initiators. The former are much more likely to be age 20 years or older, non-Hispanic white, have 16+ years of education, and married, and less likely to have Medicaid-financed births and to be foreign born (Table 1).

Eleven percent of the mothers in the sample had their second child within 18 months of the first, 74% had their second child between 18 months and 5 years after the first, and 15% had their second child 5 or more years after the first (Table 2). Timing of prenatal care, adequacy of prenatal care according to the GINDEX-revised, and all sociodemographic characteristics are significantly associated with subsequent birth interval. Early prenatal care, at least “adequate” prenatal care, being non-Hispanic white, being US born, having 16+ years of education, being married, and not being on Medicaid are all associated with a lower likelihood of short and long birth intervals as we have defined them. Teenage mothers have the highest rates of both short and long birth intervals, whereas mothers age 34 are the least likely group to have long birth intervals.

Consistent with the bivariate results in Table 2, trimester of prenatal care initiation is associated with timing of subsequent birth in a multivariate context (Table 3). Most importantly, initiating prenatal care after the first trimester is strongly associated with a short birth interval (<18 months). The odds of having a second child in fewer than 18 months (compared to 18 to 59 months) are 19% higher if the mother initiated prenatal care during her second trimester of pregnancy as opposed to her first. The odds of a short birth interval are even higher for mothers who initiated care in the third trimester (OR = 1.26) and higher yet for those not getting any prenatal care (OR = 1.61). In contrast, and as hypothesized, the association between timing of prenatal care and long birth intervals (>=60 month) is much

weaker, with no statistically significant associations. In auxiliary models, not shown, we controlled for county of residence rather than hospital of birth and adjusted the standard errors for clustering at the county level. The estimated effects of prenatal care were insensitive to this alternative specification.

The associations between control variables and birth intervals are also consistent with those shown in Table 2. Young maternal age (<20 years) is associated with both short and long birth intervals. Older age (35+ years) is associated with short intervals, but negatively associated with long birth intervals (reflecting decreased fecundity at advanced maternal age). Non-Hispanic black and Hispanic women are more likely than non-Hispanic white women to have birth spacing outside of the 18 to 59 month interval. Immigrant status and having less than 16 years of education are both positively associated with both short and long birth intervals. Missing father information for the first birth is negatively associated with short birth intervals and positively associated with long birth intervals. Controlling for father information being available, unmarried and married mothers are equally likely to have short birth intervals, while unmarried mothers are much more likely than married mothers to have long intervals. Poverty (as proxied by Medicaid birth) is positively associated with both short and long birth intervals.

Considering adequacy rather than just timing of prenatal care, the odds of having a second birth within 18 months (relative to 18 to 59 months) are 23% greater if a woman had inadequate versus adequate care (Table 4). In fact, the odds ratio for inadequate care is very similar to the odds ratios for second and third trimester care in Table 3.

The results from the analyses stratified by education, which are limited to mothers at least 25 years old, are generally consistent with our predictions (Table 5). Second trimester prenatal care initiation (versus first) is positively and significantly associated with short birth intervals among the low educated mothers only. However, the overall magnitudes of the associations between prenatal care timing and subsequent birth intervals are not all that different for the two groups. In general, we would not read too much into the estimated effects of no prenatal care, particularly in subgroup analyses. Only 400 mothers in the entire sample, and 30 in the subsample of mothers with 16+ years of education, had no prenatal care.

We assessed the sensitivity of our estimated effects of timing of first prenatal care visit on short birth intervals (from Table 3) to the use of logistic regression with short birth interval as a binary outcome, the use of inter-pregnancy intervals rather than birth intervals as the outcome, and using alternative cutoffs for both birth intervals and inter-pregnancy intervals. The estimated effects of timing of prenatal care and most covariates on birth interval < 18 months in the logistic regression model (Table 5) were almost identical to those in the multinomial logistic model for birth interval < 18 months (Table 3) and to logistic regression estimates of the effects of timing of prenatal care on inter-pregnancy interval < 9 months (Table 5). The latter result is not surprising since, as discussed earlier, a birth interval of 18 months is almost the same as an inter-pregnancy interval of 9 months in our data. Likewise, the estimated effects of prenatal care timing on birth intervals < 21 months were almost identical to those on inter-pregnancy intervals < 12 months. Finally, for a given outcome (birth interval or inter-pregnancy interval), the estimates were insensitive to the cutoff used.

We conducted supplementary analyses corresponding to Table 3 that a) limited the sample to mothers at least 25 years old, b) limited the sample to US born mothers, and c) stratified the sample by Medicaid birth. In all cases, the estimated effects of prenatal care timing on subsequent birth interval were very similar to those for the full sample. Specifically, effects of second and third trimester prenatal care (compared to first trimester care), were positively

and statistically significantly associated with short birth intervals, and with the exception of third trimester care among US born mothers (statistically significant odds ratio of .83), not associated with long birth intervals.

We further validated the findings from Table 3 using month rather than trimester of prenatal care initiation and using the Adequacy of Prenatal Care Utilization index (APNCU), and the negative association between greater intensity of prenatal care and short birth spacing were replicated in both cases. Furthermore, in both instances, a clear dose response was apparent.

Finally, we estimated models corresponding to those in Table 3 that were stratified by maternal age (<20 and 20+), race/ethnicity, and marital status, all of which were associated with sample loss. The estimated effects of prenatal care timing were very similar for teens and non-teens and for married and unmarried mothers. The association between timing of prenatal care and subsequent birth intervals was somewhat smaller among non-Hispanic blacks (who have higher rates of missing data) than among non-Hispanic whites, suggesting that estimates for the full sample in Table 3 might be slightly inflated. However, the inflation resulting from this source is unlikely to be substantial as the rate of missing data is low even among non-Hispanic blacks and non-Hispanic blacks account for less than 15% of the total sample.

Discussion

Much prior research on maternal and infant health has pointed to disappointing effects of prenatal care on important outcomes such as birth weight and gestational age. This may be because, for many women, the intervention is “too little, too late” to affect the outcome of the current pregnancy. Recent research provides evidence that prenatal care affects subsequent health behaviors including postpartum cigarette smoking, use of well child care, and possibly breastfeeding, in favorable directions.[15] Such behavioral changes may improve maternal postpartum health and confer an array of long term protective effects. In this vein, this study asked whether prenatal care use in a first birth is associated with women’s ability to time their second births more consistently with public health guidelines—that is, whether prenatal care affects “optimal” subsequent birth spacing. While our data contain no direct measures of family planning or fertility-related behavior, short birth intervals are de facto evidence of fertility control.

Our findings provide strong evidence that greater exposure to prenatal care during a first pregnancy is associated with more optimal spacing, and likely with fertility control. Not only are the estimated effects of prenatal care on subsequent short birth intervals large, statistically significant, and robust to numerous model specifications, there appear to be dose response effects. We also found that the estimated effect of first versus second trimester prenatal care is larger among women we hypothesized would be most affected, namely those with low educational attainment.

While there is strong interest in non-formal education programs designed to educate and empower women in terms of fertility control in developing countries, little attention has been paid to this approach in the US. Our findings suggest that the potential benefits of family planning during what may be one of the first encounters with the preventive health care system for many women in the US should be further investigated, as its potential impact on population health is large. Although most mothers report receiving family planning counseling from their prenatal care providers, existing guidelines vis-à-vis the content of this counseling are vague and we know of no data on whether birth spacing in particular is discussed. Future research should explore the content of this counseling and its associations with birth spacing and other subsequent reproductive outcomes. More

generally, our findings also add to a growing body of evidence that prenatal care confers indirect benefits that should not be overlooked.

Our study is subject to certain limitations. First, we studied a relatively constrained time period (women having a first birth between 1996 and 2000) in only one state. The linked birth records also exclude women who moved out of the state between a first and second birth. However, New Jersey, more than just about any other state, reflects the US population composition and diversity[30] and our sample includes all first and second birth pairs in the state during a recent observation window, a population that is not subject to non-response bias. These attributes make us confident that our results are not narrowly confined.

Second, the data are limited to live births, limiting our analyses of inter-pregnancy intervals, which may be more under women's control than are their birth intervals and hence more amendable to family planning intervention. Assessing the effects of prenatal care and other educational interventions on inter-pregnancy intervals is a potentially promising direction for future research, as IPI cutoffs are a potentially useful family planning counseling tool.

Third, despite our attempts to isolate causal effects by controlling for many possible confounding factors including hospital of birth and Medicaid status, it is possible that the strong associations between prenatal care and short birth intervals we found reflect omitted "third" factors that are associated with both prenatal care use and birth spacing. However, even if the observed associations do not reflect causal effects, the findings from this study point to late prenatal care in the first birth as a clear risk factor for having a second birth too soon. As such, the findings suggest that prenatal providers should capitalize on their limited encounters with mothers who initiate prenatal care late or use it sporadically to make information about family planning available.

The findings from this study are particularly timely, given that several states, including New Jersey, have eliminated state funding for family planning and there are proposals to do the same at the federal level. The dwindling of public family planning resources makes it all the more imperative to learn about and exploit the potential of prenatal care, which is used by almost all women giving birth, to make up some of the gap. While this strategy cannot prevent unwanted first births, it nevertheless has enormous potential given recent figures indicating that 75% of unwanted births occur to women who have already had at least one live birth.[31]

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REFERENCES CITED

1. Centers for Disease Control and Prevention, The Healthy People 2010 Database. [accessed Jan. 20, 2011] Focus area: 09-Family Planning. 2011. http://wonder.cdc.gov/data2010
2. Conde-Agudelo A. Rosas-Bermúdez A and Kafury-Goeta A, Birth spacing and risk of adverse perinatal outcomes: a meta-analysis. JAMA. 2006; 295(15):1809–1823. [PubMed: 16622143]
3. Reichman N. Low birth weight and school readiness. The Future of Children. 2005; 15 (1):91–116. [PubMed: 16130543]
4. Cheslack-Postava K, Liu K, Bearman P. Closely spaced pregnancies are associated with increased odds of autism in California sibling births. Pediatrics. 2011; 127(2):246–253. [PubMed: 21220394]
5. Kogan M, et al. The changing pattern of prenatal care utilization in the United States, 1981–1995, using different prenatal care indices. JAMA. 1998; 279(20):1623. [PubMed: 9613911]

6. Schappert S. Ambulatory care visits to physician offices, hospital outpatient departments, and emergency departments: United States, 1996. Vital Health Statistics. 1998; 13 (134):1–37. [PubMed: 9564280]

7. March of Dimes. During your pregnancy: prenatal care. Pregnancy and Newborn Health Education Center; http://www.marchofdimes.com/pnhec/159_513.asp [accessed Jan. 21, 2011]

8. U.S. Department of Health and Human Services. Caring for Our Future: The Content of Prenatal Care: A Report of the Public Health Service Expert Panel on the Content of Prenatal Care. Washington, DC: 1989.

9. Martin J, et al. Births: Final data for 2006. National Vital Statistics Reports. 2009; 57(7) http://www.cdc.gov/nchs/data/nvsr/nvsr57/nvsr57_07.pdf.

10. March of Dimes. [accessed Jan. 7, 2011] Distribution of prenatal care adequacy categories: US. 2002. http://www.marchofdimes.com/peristats/level1.aspx?dv=ms&reg=99&top=5&stop=33&lev=1&slev=1&obj=3

11. U.S. Department of Health and Human Services. Maternal, Infant, and Child Health. Healthy People 2010 (2). 2 Chapter 16, http://www.healthypeople.gov/2010/Document/HTML/Volume2/16MICH.htm.

12. Reichman N, et al. Infant health production functions: what a difference the data make. Health Economics. 2009; 18(7):761–782. [PubMed: 18792077]

13. Reichman N, Teitler J. Timing of enhanced prenatal care and birth outcomes in New Jersey's HealthStart program. Maternal and Child Health Journal. 2005; 9(2):151–158. [PubMed: 15965620]

14. Kistin N, et al. Breast-feeding rates among black urban low-income women: effect of prenatal education. Pediatrics. 1990; 86(5):741–746. [PubMed: 2235229]

15. Reichman N, et al. Effects of prenatal care on maternal postpartum behaviors. Review of Economics of the Household. 2010; 8(2):171–197. [PubMed: 20582158]

16. Hernandez LE, et al. Is Effective Contraceptive Use Conceived Prenatally in Florida? The Association Between Prenatal Contraceptive Counseling and Postpartum Contraceptive Use. Maternal and Child Health Journal. epub ahead of print.

17. Personal communication with custom tabulation from Denise V. D'Angelo, PRAMS Program Manager, Division of Reproductive Health, CDC dated March 9, 2009.

18. Cleland K, et al. Family Planning as a Cost-Saving Preventive Health Service. New England Journal of Medicine. 2011; 364(18):e37. [PubMed: 21506736]

19. Frost JJ, Finer LB, Tapales A. The impact of publicly funded family planning clinic services on unintended pregnancies and government cost savings. Journal of Health Care for the Poor and Underserved. 2008; 19(3):778–796. [PubMed: 18677070]

20. Halpern V, et al. Strategies to improve adherence and acceptability of hormonal methods for contraception. Cochrane Database Syst Review. 2011:CD004317.

21. Moos MK, Bartholomew NE, Lohr KN. Counseling in the clinical setting to prevent unintended pregnancy: an evidence-based research agenda. Contraception. 2003; 267(2):115–132. [PubMed: 12586322]

22. Van Landingham M, Trussell J, Grummer-Strawn L. Contraceptive and health benefits of breastfeeding: a review of the recent evidence. International Family Planning Perspectives. 1991; 17(4):131–136.

23. Jejeebhoy, SJ. Women's education, autonomy, and reproductive behaviour: Experience from developing countries. Oxford University Press; USA: 1996.

24. Moulton, J. [accessed Jan. 30, 2011] Formal and Nonformal Education and Empowered Behavior. Prepared Project. 1997. Funded by USAID/AFR/SD. http://pdf.usaid.gov/pdf_docs/PNACB230.pdf

25. Freed G, et al. Influences on the receipt of well-child visits in the first two years of life. Pediatrics. 1999; 103(4):864–869. [PubMed: 10103323]

26. Kogan M, et al. The association between adequacy of prenatal care utilization and subsequent pediatric care utilization in the United States. Pediatrics. 1998; 102(1):25–30. [PubMed: 9651409]

27. Henshaw S. Unintended pregnancy in the United States. Family Planning Perspectives. 1998; 30(1):24–46. [PubMed: 9494812]

28. Denk, C.; Kruse, L. Operational Assessment of Linked Files: Time for Some Standards?. 2nd International Symposium on Successive Pregnancy Outcomes: A Decade of Progress; New Brunswick, NJ. 2005. Paper available upon request from C Denk (Charles.Denk@doh.state.nj.us)
29. Alexander G, Kotelchuck M. Quantifying the adequacy of prenatal care: a comparison of indices. Public Health Reports. 1996; 111(5):408–418. [PubMed: 8837629]
30. U.S. Congress, America's Changing Profile. Hearings before the Subcommittee on Census and Population of the Committee on Post Office and Civil Service. House of Representatives, One Hundred Second Congress, Second Session; May-September 1992; U.S. Government Printing Office; 1994. Serial No. 102–64
31. Personal communication with figure based on the NSFG from Lawrence Finer dated July 14, 2011.

Table 1

Sample characteristics by timing of initiation of prenatal care (column percentages)

		Timing of first prenatal care visit (month of gestation)			
	All mothers	**1 – 3 months**	**4 – 6 months**	**7 – 9 months**	**No Care**
Age ***					
< 20 years	14.0	10.0	35.5	39.5	55.5
20 – 34	79.4	82.7	61.4	57.9	42.5
35 +	6.6	7.3	3.0	2.7	2.0
Race/Ethnicity ***					
Non-Hispanic white	62.7	67.5	36.0	32.7	31.3
Non-Hispanic black	11.9	9.6	24.4	26.5	40.3
Hispanic	16.7	14.4	30.3	30.7	23.5
Other	8.6	8.5	9.2	9.9	4.8
Nativity ***					
US born	76.1	78.0	65.9	62.3	79.0
Foreign born	23.9	22.0	34.1	37.7	21.0
Education ***					
< 12 years	13.2	9.7	32.6	36.4	48.3
12–15	47.5	47.1	50.0	47.0	44.3
16+	39.3	43.2	17.4	16.6	7.5
Marital Status ***					
Married with father information	71.9	77.5	40.5	38.2	14.8
Unmarried with father information	22.2	18.5	44.7	40.5	44.5
No father information	5.9	4.0	14.8	21.3	40.8
Medicaid Birth ***					
Yes	20.9	16.3	47.3	48.6	29.3
No	79.1	83.7	52.7	51.4	70.7
N	113662	96914	13508	2840	400
% of sample	100	85	12	3	<1

*** p < .001 from chi square tests of equal proportions.

Table 2

Sample characteristics by subsequent birth interval (row percentages)

	< 18 months	18–59 months	>= 60 months	Total
All mothers ***	10.9	74.4	14.6	100.0
Timing of first prenatal visit ***				
1 – 3 months	10.4	76.1	13.5	100.0
4 – 6	13.9	65.1	21.1	100.0
7 – 9	14.9	65.1	20.0	100.0
No prenatal care	17.5	57.3	25.3	100.0
Prenatal care adequacy (GINDEX – revised) ***				
Intensive	10.2	76.0	13.8	100.0
Adequate	10.3	76.4	13.3	100.0
Intermediate	10.8	74.1	15.1	100.0
Inadequate	14.0	68.1	17.9	100.0
Missing	11.3	75.3	13.4	100.0
No prenatal care	16.7	57.9	25.4	100.0
Age ***				
< 20 years	14.2	59.9	25.9	100.0
20 – 34	10.2	76.4	13.4	100.0
35 +	12.9	81.2	5.9	100.0
Race/Ethnicity ***				
Non-Hispanic white	9.9	79.3	10.8	100.0
Non-Hispanic black	13.8	62.2	24.1	100.0
Hispanic	13.0	65.2	21.8	100.0
Other	10.4	74.0	15.5	100.0
Nativity ***				
US born	10.6	75.8	13.6	100.00
Foreign born	12.0	70.1	17.8	100.0
Education ***				
< 12 years	14.9	61.6	23.5	100.0
12–15	11.3	71.2	17.5	100.0
16+	9.2	82.7	8.1	100.0
Marital Status ***				
Married with father information	10.4	79.8	9.9	100.0
Unmarried with father information	12.5	61.5	26.0	100.0
No father information	12.2	58.3	29.5	100.0
Medicaid Birth ***				
Yes	14.1	61.1	24.8	100.0
No	10.1	78.0	11.9	100.0
N	12437	84609	16616	113662

*** p < .001 from chi square tests of equal proportions.

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Table 3

Odds ratios from multinomial logistic regression model of associations between timing of prenatal care and subsequent birth interval (N = 113662)

	< 18 months	>= 60 months
Timing of first prenatal visit		
1 – 3 months	1.00	1.00
4 – 6	1.19***	1.03
7 – 9	1.26***	0.94
No prenatal care	1.61***	1.15
Age		
< 20 years	1.14***	1.09*
20–34	1.00	1.00
35+	1.33***	0.58***
Race/ethnicity		
Non-Hispanic white	1.00	1.00
Non-Hispanic black	1.31***	1.32*
Hispanic	1.11*	1.24***
Other	1.06	1.46***
Nativity		
US born	1.00	1.00
Foreign born	1.08**	1.23***
Education		
< 12 years	1.45***	1.36***
12–15	1.26***	1.60***
16+	1.00	1.00
Marital Status		
Married with father information	1.00	1.00
Unmarried with father information	.97	2.44**
No father information	.86*	2.51***
Medicaid Birth		
Yes	1.23***	1.09**
No	1.00	1.00
McFadden's pseudo R-squared	.05	
Degrees of freedom	69	

Notes: Model includes hospital and year indicators with adjusted standard errors to account for clustering by hospital. Reference birth interval is 18–59 months.

* p<0.05

** p<0.01

*** p<0.001

Table 4

Odds ratios from multinomial logistic regression model of associations between prenatal care adequacy and subsequent birth interval (N=113662)

	< 18 months	>= 60 months
GINDEX-revised classification		
Intensive	0.97	1.01
Adequate	1.00	1.00
Intermediate	1.01	0.97
Inadequate	1.23***	0.95
Missing	1.08	0.94
No prenatal care	1.53**	1.13
Age		
< 20 years	1.15***	1.10*
20–34	1.00	1.00
35+	1.33***	0.58***
Race/ethnicity		
Non-Hispanic white	1.00	1.00
Non-Hispanic black	1.31***	1.32***
Hispanic	1.12*	1.24***
Other	1.06	1.46***
Nativity		
US born	1.00	1.00
Foreign born	1.09**	1.23***
Education		
< 12 years	1.46***	1.36***
12–15	1.26***	1.60***
16+	1.00	1.00
Marital Status		
Married with father information	1.00	1.00
Unmarried with father information	0.98	2.45***
No father information	0.87*	2.52***
Medicaid birth		
Yes	1.24***	1.09**
No	1.00	1.00
McFadden's pseudo R-squared	.05	
Degrees of freedom	71	

Notes: Model includes hospital and year indicators with adjusted standard errors to account for clustering by hospital. Reference birth interval is 18–59 months. p<0.05

** p<0.01

*** $p<0.001$

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Table 5

Odds ratios from multinomial logistic regression models of associations between timing of prenatal care and subsequent birth interval by maternal education (mothers age 25+ only)

	< 16 years (N= 33653)		*16+ years* (N=42418)	
	< 18 months	*>=60 months*	*< 18 months*	*>=60 Months*
Timing of first prenatal visit				
1 – 3 months	1.00	1.00	1.00	1.00
4 – 6	1.23**	1.01	1.07	1.01
7 – 9	1.28	1.02	1.35	1.05
No prenatal care	1.75	1.46	3.87	5.24
Age				
25 – 34 years	1.00	1.00	1.00	1.00
35+	2.47***	1.90***	1.95***	1.35***
Race/ethnicity				
Non-Hispanic white	1.00	1.00	1.00	1.00
Non-Hispanic black	0.78**	0.64***	0.73**	0.56***
Hispanic	0.78**	0.69***	0.87	0.69***
Other	0.82*	0.68***	0.56***	0.61***
Nativity				
US born	1.00	1.00	1.00	1.00
Foreign born	1.12	0.95	0.71***	0.65***
Marital Status				
Married with father information	1.00	1.00	1.00	1.00
Unmarried with father information	0.66***	0.51***	0.34***	0.36***
No father information	0.36***	0.40***	0.26***	0.18***
Medicaid birth				
Yes	1.07	0.88*	1.28	0.95
No	1.00	1.00	1.00	1.00
McFadden’s pseudo R-squared	.03		.03	
Degrees of freedom	70		68	

Notes: Models include hospital and year indicators with adjusted standard errors to account for clustering by hospital. Reference birth interval is 18–59 months. p<0.05

** p<0.01

*** p<0.001

Table 6

Odds ratios from logistic regression models of associations between timing of prenatal care initiation and short birth and inter-pregnancy intervals, using alternative cutoffs

	Birth Interval		**Inter-Pregnancy Interval**	
	< 18 months	**< 21 months**	**< 9 months**	**< 12 months**
Timing of first prenatal visit				
1 – 3 months	1.00	1.00	1.00	1.00
4 – 6 months	1.19***	1.17***	1.19***	1.17***
7 – 9 months	1.28***	1.21**	1.29***	1.20**
No prenatal care	1.56***	1.58***	1.48**	1.52***
Age				
< 20	1.11**	1.04	1.11**	1.04
20 – 34 years	1.00	1.00	1.00	1.00
35+	1.39***	1.44***	1.38***	1.42***
Race/ethnicity				
Non-Hispanic white	1.00	1.00	1.00	1.00
Non-Hispanic black	1.25***	1.19***	1.23***	1.17***
Hispanic	1.07	1.03	1.08	1.01
Other	1.01	0.93	0.98	0.91
Nativity				
US born	1.00	1.00	1.00	1.00
Foreign born	1.05	1.05	1.05	1.05
Education				
< 12 years	1.43***	1.29***	1.43***	1.29***
12–15	1.20***	1.08*	1.19***	1.07*
16+	1.00	1.00	1.00	1.00
Marital Status				
Married with father information	1.00	1.00	1.00	1.00
Unmarried with father information	0.81***	0.73***	0.80***	0.73***
No father information	0.69***	0.64***	0.68***	0.64***
Medicaid birth				
Yes	1.20***	1.17***	1.21***	1.17***
No	1.00	1.00	1.00	1.00
N	**113649**	**113656**	**113649**	**113656**
McFadden's pseudo R-squared	0.01	0.01	0.01	0.01
Degrees of Freedom	17	18	17	18
Number of Clusters	71	72	71	72

Notes: Models include hospital and year indicators with adjusted standard errors to account for clustering by hospital. The reference category in each model includes all birth or inter-pregnancy intervals below the relevant cutoff. Inter-pregnancy interval is calculated as the birth interval minus the gestational age of the second child; this is equivalent to the interval from the date of birth of the first child to the estimated date of

conception of the second child. Sample sizes were slightly lower than that in Table 3 because observations were lost due to perfect collinearity.

Table p<0.05

** p<0.01

*** p<0.001

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