

# Short and Long Interpregnancy Intervals: Correlates And Variations by Pregnancy Timing Among U.S. Women

**CONTEXT:** Short and long interpregnancy intervals are associated with adverse health outcomes. Little is known about the correlates of short and long interpregnancy intervals in the general population, and whether correlates vary by pregnancy intention.

**METHODS:** Data on 10,236 pregnancies following a live birth were drawn from the 1995, 2002 and 2006–2010 waves of the National Survey of Family Growth. Logistic regression was used to assess characteristics associated with women's reporting short interpregnancy intervals (less than 12 months) and long intervals (greater than 60 months). Analyses were stratified by whether women considered their pregnancies well timed or mistimed.

**RESULTS:** Thirty-one percent of pregnancies following short intervals and 47% following long intervals were well timed. Among well-timed pregnancies only, the odds of short intervals were elevated if women had been 35 or older, rather than aged 20–29, at last pregnancy (odds ratio, 2.3); if their prior infant had died (10.6); or if they had wanted their prior pregnancy sooner than it had occurred (2.2). Overall, the odds of long intervals were higher among minority groups than among whites (1.4–1.6) and were lower among women who had been 30 or older at prior pregnancy than among those who had been in their 20s (0.1–0.5); they increased with level of family income. Correlates of long intervals generally varied little by intention.

**CONCLUSIONS:** Although the majority of pregnancies at short intervals are unintended, specific subsets of women have elevated odds of intending short interpregnancy intervals.

*Perspectives on Sexual and Reproductive Health, 2015, 47(1):19–26, doi: 10.1363/47e2615*

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Interpregnancy interval, the time between a birth and the next conception, represents a potentially modifiable feature of the prenatal environment. Both relatively short and long intervals have been associated with adverse perinatal and maternal outcomes. In particular, a meta-analysis of 67 studies showed that relative to interpregnancy intervals of 18–23 months, intervals of less than 18 and greater than 59 months were associated with higher risks that an infant would be preterm, low-birth-weight or small for gestational age.<sup>1</sup> Additionally, a systematic review found evidence to suggest that while definitions of short and long vary across studies, relatively longer interpregnancy intervals are associated with higher risks of preeclampsia and labor dystocia, and relatively shorter interpregnancy intervals are associated with higher risks of uterine rupture in attempted vaginal birth after cesarean section, placental abruption and placenta previa.<sup>2</sup> Moreover, emerging evidence suggests that shorter interpregnancy intervals (less than six to less than 12 months) are associated with higher risk of neurodevelopmental disorders, including autism<sup>3,4</sup> and schizophrenia,<sup>5</sup> and that longer intervals (greater than 60 months) are associated with higher risk of autism spectrum disorders.<sup>6</sup>

Existing literature has focused mainly on the correlates of short interpregnancy intervals among “at-risk” populations—adolescents in particular.<sup>7–11</sup> A more limited

number of studies have addressed correlates of extremes of interpregnancy intervals in samples of the general population; in these studies, extremely long or short intervals have been associated predominantly with markers of maternal social disadvantage. Studies from the United States and Europe have found a higher occurrence of both short interpregnancy intervals (less than six to less than 12 months) and long intervals (greater than 60 or greater than 120 months) among women who had relatively little education,<sup>12–14</sup> were immigrants<sup>12</sup> or of minority race or ethnicity,<sup>12–14</sup> were unmarried at the time of the birth,<sup>12,14</sup> were relatively young,<sup>2,12,14</sup> were enrolled in Medicaid,<sup>12</sup> or had received late or inadequate prenatal care in the preceding pregnancy.<sup>12</sup> A lack of access to or use of effective contraceptives, unemployment or living in housing types associated with low social status,<sup>15</sup> and having had more than two previous births<sup>15</sup> have also been associated with short interpregnancy intervals.<sup>16,17</sup>

Outcomes and circumstances of the preceding pregnancy have also been associated with the length of the interpregnancy interval. Shorter interpregnancy or birth intervals have been observed following an infant death,<sup>18</sup> a stillbirth,<sup>13,18</sup> a premature birth<sup>13</sup> or delivery of a low-birth-weight infant;<sup>13</sup> breast-feeding has been associated with longer intervals.<sup>18,19</sup> Relative to vaginal delivery, cesarean delivery is associated with a lower likelihood of having

a future birth;<sup>20,21</sup> given this association, whether mode of delivery is also related to the length of the intervals preceding the next pregnancy should be considered. Finally, among adolescents, higher risk of rapid repeat pregnancy has been associated with having an intended first pregnancy.<sup>7,22</sup>

Characteristics associated with the length of the interpregnancy interval may vary according to pregnancy intention. Findings of higher prevalence of short interpregnancy intervals among older mothers<sup>12,13,15</sup> have been interpreted as evidence that delayed childbearing creates a time pressure to complete a family of a desired size. Moreover, Gemmill and Lindberg, using data from the National Survey of Family Growth (NSFG), found that characteristics indicating socioeconomic advantage were associated with higher odds that pregnancies following relatively short intervals were intended, as opposed to unintended.<sup>23</sup> However, because the pregnancies of advantaged women are more likely to be intended than are those of disadvantaged women overall,<sup>24</sup> it is not clear to what extent this elevated likelihood of intendedness is unique to pregnancies following short intervals. Other characteristics that may be associated specifically with intentional short or long interpregnancy intervals have not been explored in depth.

To address knowledge gaps about correlates of short and long interpregnancy intervals, we undertook a study using extensive data from the NSFG. We focused on intervals of less than 12 months and greater than 60 months because those intervals are most strongly associated with adverse health outcomes.<sup>1,3,6</sup> Our aims were to determine which characteristics of women and their previous pregnancies are associated with the odds of short or long interpregnancy intervals, and to assess whether characteristics associated with the risk of short or long intervals differ by pregnancy intention. We hypothesized that they would differ to the extent that correlates of intended pregnancies reflect deliberate choice rather than general variation in fertility or risk of pregnancy.

## METHODS

### Sample

Data were drawn from the public-use pregnancy interval files of the 1995, 2002 and 2006–2010 waves of the NSFG. The NSFG is an interview-based study of a nationally representative sample of women (and, beginning in 2002, men) aged 15–44. It has been conducted periodically since 1973 to collect data on birth and pregnancy rates, family formation and risk of STDs. Data from three waves were included to maximize the sample size.

The three waves of the NSFG included data on 55,417 pregnancies among 20,332 women. To increase accuracy of recall and because some survey questions were asked only for pregnancies that had occurred in the previous five years, we restricted our sample to pregnancies that had occurred within five years of the interview date; this yielded a sample of 17,384 pregnancies. From among these pregnancies, we

excluded 6,578 because they did not follow a live birth, 525 because they did not have information on length of gestation and 45 because the interpregnancy interval was calculated to be less than or equal to zero months. Pregnancies meeting the sample's eligibility criteria were included regardless of outcome, and multiple pregnancies per woman were included if they met the criteria, so that the sample would be representative of all pregnancies in the United States. This resulted in a sample of 10,236 pregnancies. Among these, 10,018 had complete information available on all covariates included in multivariate models.

### Measures

Interpregnancy interval was calculated in months and defined as the time between the prior live birth and the end date of the included pregnancy minus gestational age. Gestational age was based on maternal recall. Prior studies comparing maternal recall of gestational age with records from the time of birth have reported moderate to very high agreement (75–96% correct within one week<sup>25,26</sup> or mean differences of 0.35 weeks or less<sup>27,28</sup>).

For pregnancies that were not complete at the time of interview, the interpregnancy interval was calculated using the interview date and the reported number of weeks pregnant at interview. Intervals of less than 12 months (“short”) and greater than 60 months (“long”) were compared with intervals of 12–60 months (“intermediate”). These cut points were selected to balance the goal of examining the extremes of interpregnancy interval with that of maintaining adequate sample size in each category.

We included variables for the survey wave and the following characteristics, as reported at the time of the interview: maternal education (less than high school, high school diploma, some college, or college degree or more), maternal race or ethnicity (Hispanic, non-Hispanic white, non-Hispanic black, other), family income as a percentage of the federal poverty level (less than 100%, 100–199%, 200–299%, 300–399%, greater than or equal to 400%) and whether the mother was born outside the United States (regardless of her race or ethnicity).

The following variables pertaining to the preceding pregnancy that ended in a live birth were included: maternal age (younger than 20, 20–29, 30–34, 35 or older), marital status (married, never-married, formerly married), parity, initiation of breast-feeding, infant death (death at less than 12 months of age), delivery of an infant who was low-birth-weight (less than 2,500g) or premature (36 or fewer weeks' gestation), cesarean delivery, and woman's report of her and her partner's opinions about the timing of the pregnancy (right time, unwanted or too soon, wanted sooner, or didn't care/indifferent or don't know). Women's opinions regarding pregnancy timing were derived from responses to two questions: “Right before you became pregnant, did you yourself want to have a baby at any time in the future?” and “So would you say you became pregnant too soon, at about the right time or later than you wanted?” The women were asked about their partner's opinion on pregnancy

timing with similar questions. Two variables hypothesized to lengthen the interpregnancy interval also were included: the experience of a pregnancy that had an outcome other than a live birth (i.e., induced abortion, miscarriage, stillbirth or ectopic pregnancy) between the prior live birth and the included pregnancy, and ever having received treatment for infertility.

The questions on pregnancy timing were also asked about the included pregnancy. We classified these pregnancies as either well timed (if the woman said she became pregnant at “the right time”) or mistimed (if she said the pregnancy had occurred earlier or later than wanted, or had been unwanted). While other researchers<sup>29</sup> have grouped pregnancies occurring later than wanted with those that occurred at the right time, the primary distinction we aimed to draw was whether the pregnancy occurred at what the mother considered to be the right time. The 198 pregnancies for which timing was reported as “don’t know” or “didn’t care/indifferent” were set to missing for this variable. Although prior work<sup>29</sup> has assigned these pregnancies to the “right time” group, we maintain the conceptual distinctions among pregnancies reported to have been well timed, mistimed or neither. However, given the small number of pregnancies in the last category (fewer than 0.01% of the total sample), we would not expect the classification of these pregnancies to affect our findings appreciably.

## Analysis

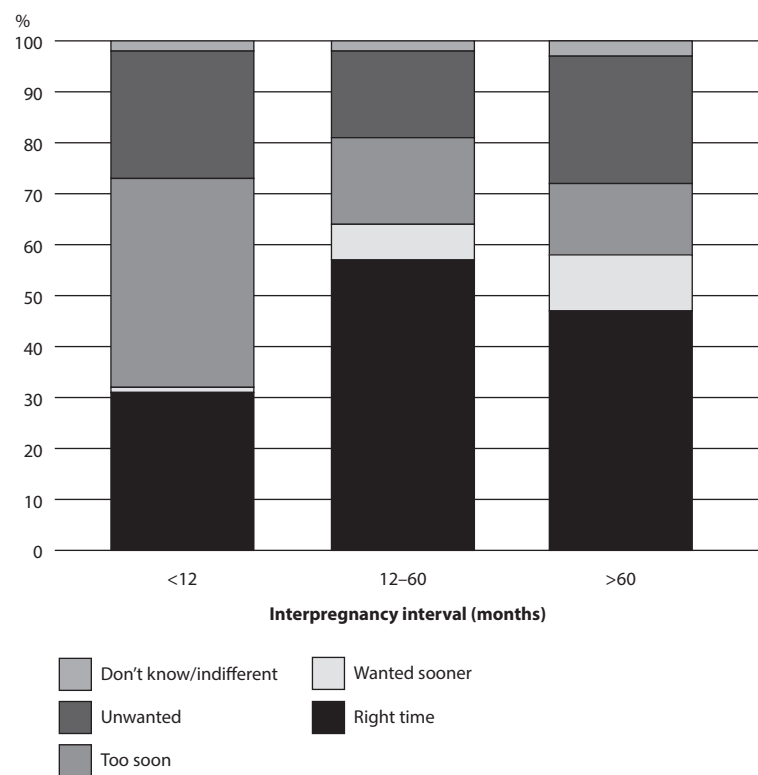
To describe the included population, timing classification of the included pregnancy was tabulated by interpregnancy interval category, and the frequencies of maternal and prior pregnancy characteristics among pregnancies with short, intermediate and long interpregnancy intervals were tabulated and compared using chi-square tests. Multivariate logistic regression was used to assess the maternal demographic and prior pregnancy characteristics associated with short and long interpregnancy intervals, while adjusting for all other covariates in the model. Analyses were conducted for the full sample and stratified by timing of the included pregnancy (well timed versus mistimed). To test the hypothesis that characteristics associated with short or long interpregnancy intervals differ between well-timed and mistimed pregnancies, stratified odds ratio estimates were compared using tests of heterogeneity.<sup>30</sup> To test the sensitivity of short interval associations to the selection of the 12-month cut point, a multivariate logistic model was fitted using intervals less than six months versus intervals of 6–60 months as the dependent variable. All analyses used sampling weights and survey procedures in Stata 10.1 to account for the complex sampling design of the NSFG.

## RESULTS

### Characteristics of Pregnancies

Seventeen percent of pregnancies occurred after intervals of less than 12 months, 62% occurred after intervals of 12–60 months and 21% occurred after intervals of greater

**FIGURE 1. Percentage distribution of pregnancies among U.S. women aged 15–44, by reported timing, according to interpregnancy interval, National Survey of Family Growth, 1995–2010**



Note: Interpregnancy interval refers to the time between the last live birth and the included pregnancy.

than 60 months. Thirty-one percent of pregnancies that followed short intervals, 57% of pregnancies that followed intermediate intervals and 47% of pregnancies that followed long intervals occurred at the right time, according to maternal report (Figure 1).

Overall, 29% of pregnancies were among women interviewed during the 1995 wave of the NSFG, 35% among women interviewed in 2002 and 36% among women interviewed in 2006–2010 (Table 1). Majorities of pregnancies were among women who were aged 20–29 at their previous birth (62%), had a high school education or less (56%), were white (58%), had an income below 200% of poverty (55%), were married (61%), were born in the United States (82%) and had breast-fed their prior infant (63%). Fewer than 1% of pregnancies followed an infant death, while 14% followed the delivery of a preterm or low-birth-weight infant. Roughly 20% of pregnancies followed a spontaneous or induced abortion, occurred among women who had ever received treatment for infertility or followed a cesarean delivery. According to maternal report, more than half of the preceding pregnancies had occurred at what women and their partners considered the right time, roughly a third had been unwanted or occurred too soon, and fewer than one in 10 had been wanted sooner.

Relative to pregnancies following intervals of 12–60 months, pregnancies following intervals of less than 12 months were more likely to occur among women who

**TABLE 1. Percentage of pregnancies, by selected characteristics of the previous pregnancy that ended in a live birth and of the mother, according to interpregnancy interval**

Characteristic	All (N=10,236)	<12 mos. (N=1,833)	12–60 mos. (N=6,265)	>60 mos. (N=2,138)
<b>Survey wave</b>				
1995	29.2	30.5	29.1	28.7
2002	34.5	32.8	35.3	33.3
2006–2010	36.3	36.7	35.6	38.0
<b>Maternal age</b>				
<20	18.2	18.3	17.2	21.0*
20–29	61.9	60.2	59.7	69.9
30–34	15.6	16.6	17.5	8.7
≥35	4.4	4.9	5.6	0.4
<b>Maternal education†</b>				
<high school	26.6	35.5*	24.1	26.7*
High school	29.1	28.0	28.8	30.9
Some college	23.8	20.3	22.6	30.3
≥college	20.6	16.1	24.5	12.0
<b>Maternal race/ethnicity†</b>				
Hispanic	20.2	21.1*	18.7	23.7*
White	57.5	52.2	61.1	50.6
Black	16.4	20.7	14.4	19.1
Other	6.0	5.9	5.8	6.6
<b>Income as % of poverty level†</b>				
<100	28.7	40.3*	26.9	24.8
100–199	26.3	28.3	25.6	27.0
200–299	16.8	12.6	17.0	19.7
300–399	15.8	10.7	17.5	14.5
≥400	12.4	8.0	13.0	14.0
<b>Marital status</b>				
Married	60.9	54.3*	64.1	56.3*
Never-married	34.8	40.3	32.1	38.4
Formerly married	4.4	5.4	3.8	5.3
<b>Parity &gt;1</b>	45.9	52.1*	44.0	46.8
<b>Mother born outside United States†</b>	17.6	16.3	17.3	19.5
<b>Breast-fed infant</b>	62.9	61.4*	65.5	56.1*
<b>Infant death</b>	0.8	1.6*	0.8	0.3*
<b>Infant low-birth-weight or preterm</b>	14.0	15.8	13.6	13.7
<b>Next pregnancy ended in loss</b>	21.1	3.2*	20.6	37.0*
<b>Mother had ever been treated for infertility</b>	20.0	17.1*	20.7	20.3
<b>Cesarean delivery</b>	21.1	18.5*	22.0	20.5
<b>Mother's opinion about timing of prior pregnancy</b>				
Right time	53.9	50.7*	56.3	49.2*
Unwanted or too soon	36.8	38.6	34.2	43.4
Wanted sooner	7.4	8.6	8.2	4.2
Indifferent/don't know	1.8	2.1	1.3	3.2
<b>Mother's report of partner's opinion about timing of prior pregnancy</b>				
Right time	55.3	54.1	57.8	48.7*
Unwanted or too soon	31.6	32.0	29.4	37.9
Wanted sooner	6.5	7.2	7.1	4.0
Indifferent/don't know	6.6	6.8	5.7	9.4

\*Distribution differs from that of interpregnancy interval of 12–60 months at  $p<.05$ . †Measured at time of interview. Notes: The p values are from chi-square tests. Percentages shown were calculated using all observations with data available for the given variable. Data were missing on breast-feeding of prior infant (2.1% of cases); mother's birthplace (0.1%); both parents' opinions about timing of prior pregnancy (<0.1%) and prior cesarean (<0.1%). Percentages are weighted.

had lower levels of education, were Hispanic or black, had lower levels of income, had had more than one child or had experienced an infant death. Relative to pregnancies following intermediate intervals, those following short intervals were less likely to occur among women who were married, had breast-fed their prior infant, had experienced a pregnancy loss, had ever been treated for infertility, had delivered their prior infant by cesarean or said that their prior pregnancy had occurred at the right time.

Pregnancies following intervals of greater than 60 months were less likely than those following intervals of 12–60 months to occur among women who had completed college or some graduate school, were married, had breast-fed their prior infant, had experienced the death of the prior infant, said that their prior pregnancy had occurred at the right time or said that their partner felt their prior pregnancy had occurred at the right time. Relative to pregnancies after intermediate intervals, pregnancies occurring after long intervals were more likely to occur among women who were younger at their prior pregnancy, were of minority race or ethnicity, had had a preceding pregnancy loss, said that their prior pregnancy was unwanted or had occurred sooner than wanted, or said that their partner felt their prior pregnancy was unwanted or had occurred too soon.

### Short Interpregnancy Intervals

In the multivariate model including all pregnancies, odds of short interpregnancy intervals were higher among black mothers than among whites (odds ratio, 1.4—Table 2) and were inversely associated with income (test for linear trend,  $p<.001$ ). The odds of short intervals were significantly lower for women with at least a high school education than for those with less education (0.6–0.7), and were reduced for women who were born outside of the United States (0.7), had experienced a pregnancy loss following the prior live birth (0.1) or had delivered their prior infant by cesarean (0.8). Results were qualitatively similar when short interpregnancy interval was defined as less than six months (not shown).

Our tests of heterogeneity revealed that several variables were associated with short interpregnancy intervals only among well-timed pregnancies. The odds that a well-timed pregnancy followed a short interval were higher for women aged 35 or older at last pregnancy than for those aged 20–29 (odds ratio, 2.3), for black women than for whites (1.7), for formerly married than for currently married women (1.7) and for those who had wanted the prior pregnancy to occur sooner than it had than for those who said they had become pregnant at the right time (2.2). The odds also were elevated if the woman's prior infant had died (10.6), and they were reduced if the prior delivery had been a cesarean (0.6).

To assess whether the observed association among well-timed pregnancies between short interpregnancy intervals and women's reports that they had wanted the prior pregnancy to occur sooner than it had was specific to older mothers, we conducted an exploratory analysis, stratifying

by maternal age. The odds ratios for women who had been younger than 20 (3.2;  $p=.20$ ) and those who had been aged 20–29 (2.5;  $p=.06$ ) suggest that the magnitude of association was just as strong among younger women as for all age-groups combined (2.2).

### Long Interpregnancy Intervals

In the multivariate model including all pregnancies, the odds of long interpregnancy intervals were positively associated with a number of maternal characteristics (Table 3): having been surveyed in 2006–2010, rather than 1995 (odds ratio, 1.3); being of a minority race or ethnicity (1.4–1.6); being formerly, rather than currently, married (1.4); having had more than one child (1.2); having experienced a pregnancy loss (2.2); and having a partner who had been negative or ambivalent about the timing of the prior pregnancy, rather than thinking it had occurred at the right time (1.4–1.8). There was a gradient of increasing odds of long interpregnancy interval associated with increasing income (test for linear trend,  $p<.001$ ). The odds of long interpregnancy interval were reduced if women had been in their 30s at the last pregnancy, rather than in their 20s (0.1–0.5); if they had had four or more years of college, rather than less than a high school education (0.6); or if they had had breast-fed their prior infant (0.7).

Black race showed evidence for heterogeneity of association by timing of the pregnancy ( $p=.02$ ): Black women's elevated odds of having a pregnancy after a long interval were attributable to well-timed pregnancies only (odds ratio, 1.9). For other characteristics for which there was significant or marginal evidence for heterogeneity between strata defined by pregnancy timing, none of the stratum-specific estimates of association were statistically significant.

### DISCUSSION

We used data from a nationally representative sample of U.S. women to examine variables associated with short and long interpregnancy intervals among pregnancies that were mistimed and well timed. While the majority of pregnancies following short and long interpregnancy intervals were mistimed, for a substantial minority in each group (almost a third of pregnancies at short intervals and half at long intervals), the mother reported that she had become pregnant at the right time. We found overall associations of extremes of interpregnancy interval with both biological characteristics and markers of socioeconomic status. We additionally found evidence to suggest that a subset of pregnancies at short intervals are characterized by intentional strategies with respect to fertility and childbearing in that certain correlates of short interpregnancy interval appeared only for well-timed pregnancies.

Our findings that the risk of pregnancy at short intervals was inversely associated with maternal education and income are consistent with other studies' findings of associations with socioeconomic disadvantage.<sup>12–15</sup> These associations held here whether the pregnancy was mistimed or well timed. This may be because of lower rates of use of

**TABLE 2. Adjusted odds ratios (and 95% confidence intervals) from multivariate logistic regression models assessing associations between selected maternal and prior pregnancy characteristics and interpregnancy intervals of less than 12 months, by reported timing of pregnancy**

Characteristic	All pregnancies (N=7,962)	Well-timed (N=3,725)	Mistimed (N=4,082)
<b>Maternal age</b>			
<20	0.83 (0.66–1.04)	0.79 (0.48–1.30)	0.83 (0.64–1.08)
20–29 (ref)	1.00	1.00	1.00
30–34	1.26 (0.99–1.60)	1.22 (0.85–1.74)	1.20 (0.88–1.65)
≥35**	1.32 (0.86–2.02)	2.32 (1.32–4.08)	0.78 (0.45–1.35)
<b>Maternal education†</b>			
<high school (ref)	1.00	1.00	1.00
High school	0.69 (0.56–0.86)	0.71 (0.48–1.06)	0.73 (0.56–0.94)
Some college	0.65 (0.51–0.82)	0.62 (0.41–0.93)	0.68 (0.51–0.92)
≥college	0.58 (0.43–0.80)	0.58 (0.35–0.96)	0.69 (0.48–1.00)
<b>Maternal race/ethnicity†</b>			
Hispanic	1.03 (0.80–1.32)	1.12 (0.68–1.82)	0.91 (0.68–1.21)
White (ref)	1.00	1.00	1.00
Black†	1.37 (1.10–1.70)	1.68 (1.15–2.45)	1.09 (0.84–1.42)
Other	1.26 (0.86–1.86)	1.08 (0.54–2.18)	1.25 (0.77–2.02)
<b>Income as % of poverty level†</b>			
<100	1.76 (1.36–2.27)	1.86 (1.19–2.93)	1.66 (1.21–2.28)
100–199	1.43 (1.11–1.85)	1.47 (0.95–2.27)	1.46 (1.06–2.02)
200–299 (ref)	1.00	1.00	1.00
300–399	0.89 (0.64–1.23)	0.81 (0.49–1.35)	1.20 (0.78–1.83)
≥400	0.87 (0.60–1.26)	0.91 (0.54–1.54)	0.78 (0.49–1.26)
<b>Marital status</b>			
Married (ref)	1.00	1.00	1.00
Never married	1.19 (0.96–1.48)	0.88 (0.59–1.33)	1.23 (0.94–1.61)
Formerly married†	1.15 (0.81–1.64)	1.69 (1.00–2.84)	0.86 (0.55–1.34)
<b>Mother born outside United States†</b>	0.69 (0.51–0.93)	0.64 (0.37–1.08)	0.75 (0.53–1.05)
<b>Infant death**</b>	2.31 (0.93–5.76)	10.6 (3.21–35.30)	0.34 (0.05–2.45)
<b>Next pregnancy ended in loss</b>	0.12 (0.09–0.16)	0.13 (0.07–0.24)	0.11 (0.07–0.16)
<b>Cesarean delivery†</b>	0.81 (0.67–0.99)	0.60 (0.44–0.83)	0.89 (0.68–1.16)
<b>Mother's opinion about timing of prior pregnancy</b>			
Right time (ref)	1.00	1.00	1.00
Unwanted or too soon	1.12 (0.92–1.37)	0.74 (0.49–1.13)	1.02 (0.80–1.30)
Wanted soonert	1.41 (0.93–2.13)	2.17 (1.08–4.35)	1.02 (0.64–1.62)
Indifferent/don't know	1.53 (0.90–2.59)	1.65 (0.58–4.69)	1.64 (0.80–3.39)

\*\* $p<.01$  in test of heterogeneity between well-timed and mistimed pregnancies. † $p<.10$  in test of heterogeneity between well-timed and mistimed pregnancies. ‡Measured at time of interview. Notes: Models adjusted for all variables in the table, as well as survey wave, parity, breast-feeding of prior infant, prior low-birth-weight or preterm infant, ever received treatment for infertility and partner's opinion about timing of the prior pregnancy. Results for characteristics not shown were not significant. Interpregnancy interval refers to the time between the last live birth and the included pregnancy. ref=reference group.

effective contraceptives and lower access to reproductive health services,<sup>31</sup> as well as greater ambivalence regarding the possibility of pregnancy<sup>32</sup> among less, relative to more, socioeconomically advantaged women.

Meanwhile, the characteristics associated with short interpregnancy intervals specifically among well-timed pregnancies identify groups of women among whom deliberately close spacing of pregnancies may be especially common. Death of the prior infant was associated with significantly elevated odds of short interpregnancy interval among well-timed pregnancies. Across a range of cultural settings, infant mortality increases fertility through a combination of behavioral mechanisms (as parents seek to replace the child they have lost) and biological ones (as fertility resumes),<sup>33</sup>

**TABLE 3. Adjusted odds ratios (and 95% confidence intervals) from multivariate logistic regression models assessing associations between selected maternal and prior pregnancy characteristics and interpregnancy intervals of greater than 60 months, by reported timing of pregnancy**

Characteristic	All pregnancies (N=8,228)	Well-timed (N=4,258)	Mistimed (N=3,979)
<b>Survey wave†</b>			
1995 (ref)	1.00	1.00	1.00
2002	1.05 (0.84–1.30)	0.98 (0.72–1.32)	0.93 (0.71–1.22)
2006–2010	1.30 (1.05–1.61)	1.07 (0.83–1.39)	1.33 (1.00–1.77)
<b>Maternal age</b>			
<20*	0.93 (0.73–1.19)	1.18 (0.85–1.66)	0.75 (0.56–1.01)
20–29 (ref)	1.00	1.00	1.00
30–34	0.51 (0.38–0.68)	0.40 (0.26–0.63)	0.62 (0.42–0.91)
≥35†	0.05 (0.02–0.13)	0.03 (0.01–0.11)	0.08 (0.03–0.23)
<b>Maternal education‡</b>			
<high school (ref)	1.00	1.00	1.00
High school	1.02 (0.81–1.29)	1.03 (0.78–1.37)	0.94 (0.70–1.26)
Some college	1.24 (0.97–1.57)	1.25 (0.89–1.75)	1.33 (0.95–1.87)
≥college	0.58 (0.42–0.80)	0.56 (0.37–0.86)	0.72 (0.46–1.13)
<b>Maternal race/ethnicity‡</b>			
Hispanic	1.62 (1.28–2.07)	1.92 (1.43–2.58)	1.48 (1.02–2.14)
White (ref)	1.00	1.00	1.00
Black*	1.41 (1.14–1.75)	1.94 (1.46–2.57)	1.18 (0.89–1.56)
Other	1.59 (1.03–2.44)	1.43 (0.83–2.48)	1.73 (1.03–2.90)
<b>Income as % of poverty level‡</b>			
<100	0.54 (0.41–0.70)	0.63 (0.45–0.89)	0.48 (0.34–0.69)
100–199	0.77 (0.59–1.00)	0.79 (0.56–1.12)	0.72 (0.52–1.00)
200–299 (ref)	1.00	1.00	1.00
300–399	1.01 (0.76–1.35)	1.17 (0.79–1.74)	0.98 (0.64–1.48)
≥400	1.46 (1.09–1.97)	1.75 (1.15–2.66)	1.19 (0.80–1.76)
<b>Marital status</b>			
Married (ref)	1.00	1.00	1.00
Never married†	0.91 (0.73–1.14)	1.09 (0.81–1.46)	0.76 (0.56–1.02)
Formerly married	1.41 (1.01–1.98)	1.51 (0.97–2.37)	1.16 (0.74–1.84)
<b>Parity &gt;1</b>	1.21 (1.00–1.45)	1.30 (1.01–1.67)	1.07 (0.84–1.36)
<b>Breast-fed infant</b>	0.73 (0.61–0.88)	0.70 (0.55–0.89)	0.78 (0.60–1.00)
<b>Next pregnancy ended in loss</b>	2.19 (1.84–2.62)	2.40 (1.91–3.01)	2.05 (1.61–2.61)
<b>Mother's opinion about timing of prior pregnancy</b>			
Right time (ref)	1.00	1.00	1.00
Unwanted or too soon†	1.01 (0.82–1.26)	1.20 (0.89–1.61)	0.84 (0.63–1.13)
Wanted sooner	0.69 (0.44–1.08)	0.51 (0.23–1.12)	0.73 (0.44–1.21)
Indifferent/don't know	2.10 (0.90–4.88)	1.13 (0.50–2.54)	1.90 (0.94–3.86)
<b>Mother's report of partner's opinion about timing of prior pregnancy</b>			
Right time (ref)	1.00	1.00	1.00
Unwanted or too soon	1.37 (1.10–1.70)	1.37 (1.02–1.85)	1.32 (1.00–1.73)
Wanted sooner	0.86 (0.53–1.38)	0.62 (0.27–1.44)	0.92 (0.53–1.59)
Indifferent/don't know	1.77 (1.24–2.51)	1.61 (1.00–2.60)	1.50 (1.02–2.23)

\* $p < .05$  in test of heterogeneity between well-timed and mistimed pregnancies. † $p < .10$  in test of heterogeneity between well-timed and mistimed pregnancies. ‡Measured at time of interview. Notes: Models adjusted for all variables in the table, as well as mother born outside United States, death of prior infant, prior low-birth-weight or preterm infant, prior delivery by cesarean section and ever having experienced infertility. Results for characteristics not shown were not significant. Interpregnancy interval refers to the time between the last live birth and the included pregnancy. ref=reference group.

our finding of association only among well-timed pregnancies supports a behavioral mechanism. Our finding that well-timed pregnancies among women who were 35 or older at their previous pregnancy ending in a live birth had elevated odds of following a short interval supports prior hypotheses that delayed childbearing is associated with decreased interpregnancy intervals<sup>13</sup> as women attempt to

reach a desired family size within a diminishing window of fertility. The association between short interpregnancy interval and a woman's report that she had wanted the prior pregnancy to occur sooner than it did further supports the interpretation of short interpregnancy interval as a "catch-up" strategy when childbearing has been delayed. This association was independent of maternal age at the prior pregnancy, and appears to be as strong among 20–29-year-old women with a well-timed pregnancy as among all age-groups combined. Finally, the inverse association between short interval and previous cesarean delivery in well-timed, but not mistimed, pregnancies may reflect awareness of an increased risk of complications in pregnancies occurring shortly after a cesarean,<sup>34</sup> particularly when a vaginal birth is attempted.<sup>35</sup>

The associations of pregnancy at longer intervals with pregnancy loss and maternal age are likely related to biological influences. Miscarriage or abortion lengthens the interpregnancy interval. Also, with older age at last pregnancy, longer interpregnancy intervals will be less frequent because of the reduced probability of conception at older maternal ages.<sup>36</sup> Such biological characteristics would be expected to operate universally, and consistent with this expectation, these associations did not vary by pregnancy timing. The associations of long interpregnancy interval with higher parity and with potential indicators of relationship instability—being formerly married and women's reports that their partner felt the prior pregnancy was unwanted or occurred too soon—also did not vary by timing of the subsequent pregnancy. These characteristics, as measured at the time of the preceding pregnancy ending in a live birth, are likely more indicative of a prolonged deferment of fertility (i.e., until the formation of a new relationship or because a desired family size had been reached) than of specific planning for a pregnancy to follow a long interval.

Black race was associated with a relatively high prevalence of both short and long intervals, specifically among well-timed pregnancies. Qualitative research among both primarily married, white women<sup>37</sup> and low-income, predominantly minority women<sup>38</sup> indicates that important variables considered in the spacing of pregnancies include desire for siblings at certain intervals and other life and career goals. Therefore, spacing pregnancies at short or long intervals may offer specific advantages to black women with respect to their social and economic trajectories. Given that in the United States, race is associated with opportunities related to social mobility,<sup>39</sup> one's neighborhood environment<sup>40</sup> and myriad other aspects of one's circumstances,<sup>41</sup> different mechanisms may be relevant with regard to short versus long interpregnancy intervals. Alternatively, black women may be more likely than others to retrospectively consider a pregnancy following a short or long interval to have occurred at the right time. A qualitative study of predominantly black inner-city women in New Orleans highlighted how variables such as ambivalence toward contraception and incongruence between ideals

about childbearing and the realities of one's life within a community may decrease the relevance of the concepts of pregnancy intention and planning,<sup>42</sup> which could affect the reporting of pregnancy timing among some groups.

Also of note, income level was inversely associated with the odds of a short interpregnancy interval and positively associated with the odds of a long interval. Interpretation is somewhat hampered by the fact that income information was available only as reported at the time of interview. Income level may be associated with the spacing of pregnancies, for example, through class-specific preferences about childspacing or through aspects of child care arrangements or employment that facilitate either closer or further spacing. Also, the length of the interpregnancy interval itself may be associated with future income if delaying an additional birth allows (or does not) for the devotion of additional time and resources to pursuing educational or career goals.

### Limitations and Strengths

Limitations should be noted. Data on women's opinions about the timing of each pregnancy were collected retrospectively. Therefore, our findings may have captured associations with women's retrospective perceptions of the timing of their pregnancies rather than with differing intentions at the time of conception. For example, older mothers may be more likely than younger women to retrospectively classify a pregnancy following a short interval as having been well timed, recognizing the possible impact of a longer wait on fertility. Such a phenomenon would not alter the substance of our findings but would have implications for their interpretation.

Although maternal education and income may change over time, we only had information that was based on report at the time of the interview. Therefore, women's reported levels for these variables may not have reflected conditions at the beginning of the interpregnancy interval. Longitudinal data will be required to better assess associations between these characteristics and length of pregnancy intervals.

Interpregnancy interval is a continuous variable, and we selected cut points to define short and long intervals on the basis of prior evidence for associations with health outcomes and the distribution of intervals within the population. We also conducted a sensitivity analysis with short intervals defined as less than six months. However, other definitions are possible, and using alternate cut points may change the magnitude or significance of the associations observed.

Finally, we used a single measure of pregnancy intention, a construct that can be defined and measured in different ways, and that overlaps with the concepts of wanting, planning and attempting to achieve a pregnancy.<sup>32</sup> Future work should investigate whether our results hold when alternate definitions are used.

Strengths of this study include a large, nationally representative sample of pregnancies drawn from the U.S. population; the availability of data on a rich array of variables, many of which were measured at the pregnancy level; and

information on women's self-reported classification of the timing of their pregnancies.

### Conclusions

Future research on the correlates of short and long interpregnancy intervals, and their intersection with intention, may build on this work in several ways. First, using prospective, longitudinal designs, in which information about pregnancy intention, in particular, is collected before conception, would reduce ambiguity about whether a woman wished to conceive when she did. Second, incorporating additional measures of pregnancy timing or intention could help to validate and provide a more nuanced exploration of this aspect of our study. Finally, examining possible interactions between characteristics associated with interpregnancy interval may help to identify more specific subgroups of women at risk for short or long intervals.

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#### Acknowledgments

This study was supported by grant 5-T32-MH-13043 from the National Institute of Mental Health. The authors thank Peter Bearman for his helpful comments on a draft of this article.

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