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Short Birth Intervals: Associated Maternal Factors and Subsequent Risk of Adverse Birth Outcomes

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Abstract

Background: The time span between pregnancies is pertinent to infant health due to the association between short interpregnancy intervals and higher risks of a low birth weight infant, preterm birth, and infant death. These associations warrant additional attention because interpregnancy intervals can be influenced by widely available birth control methods.

Analysis objectives: 1) Identify factors significantly associated with short (1-6 months) inter-pregnancy interval and 2) examine the association between short inter-pregnancy intervals and four adverse birth outcomes: low birth weight, preterm birth, small-for-gestational age, and infant death.

Methods: Florida live birth records for a singleton, first-born 1998-2003 birth cohort were linked to birth records of second-born infants of the same mother. The interval between the first birth and conception of the second birth was calculated using the dates of first birth and last menses for second births. Births with intervals above 36 months and births with no matching second birth were excluded.

Results: After adjusting for 13 covariates, women whose race was Black and had less than a high school education or an infant death with the first birth, were significantly more likely to conceive again within 6 months of the first birth. Black women who were born outside of the U.S. were significantly less likely to conceive again within 6 months. (Table 4) For White and other race women, maternal age > 35 or < 18, education < High school, tobacco use, unmarried marital status, foreign born, late or no prenatal care, preterm first birth, small for gestational age first birth, and infant death of first birth, were all associated with increased risk of conceiving again within 6 months of the first birth. (Table 4)

After adjusting for adverse outcomes at first birth, intervals of 1-6 months between the first birth and conception of the second birth were associated with increased risk of infant death, low birth weight and small for gestational age outcomes for the second birth. (Table 5)

Conclusions: In addition to other factors, infant death, low birthweight and preterm delivery at first birth are associated with higher risk of a 1-6 months interval between the first birth and conception of the second birth. After adjusting for adverse outcomes (infant death, low birth weight, preterm birth and small for gestational age) at first birth, intervals of 1-6 months are associated with increased risk of infant death, low birth weight and small for gestational age outcomes for the second birth.

Introduction

The time span between births is a subject of great interest in the field of Maternal and Child Health due to the association between short birth intervals and adverse birth outcomes. [1,2] This is especially relevant since birth intervals can often largely be determined by family planning and the use of contraceptive methods that are widely available. A detailed examination is warranted to identify factors that are associated with birth interval length and also learn how birth intervals might influence the health of Florida's infants.

This analysis has two purposes:

1) To identify factors significantly associated with short birth intervals

2) To examine the association between short birth intervals and four adverse birth outcomes, low birth weight, preterm birth, small-for-gestational age, and infant death.

Methods

Data and Selection Criteria

The birth records of first-born infants born between 1998 and 2003 who were not part of a multiple birth (twins, triplets, etc) were linked to the birth records of their second-born siblings with the same mother. The link was accomplished using the mother's social security number and year of birth as linking keys. Infant birth records with a matching social security number and birth year of the mother were assumed to be infants born to the same mother.

The time span between the first birth and the date of last menses for the corresponding second birth was calculated and assigned to 6-months birth intervals categories: 1-6 months, 7-12 months, 13-18 months, 19-24 months, 25-30, and 31-36 months. Births with intervals more than 36 months and births with no matching second birth were excluded from the analysis. In instances where the second birth record indicated there was a non-live birth pregnancy outcome between the first and second births, the births were excluded. All births that occurred between 1998 through 2007 were used in the linking process. For first births occurring between 1998 and 2003, there is at least a 36-months interval between the first birth and conception of the second birth. Second births could have occurred through calendar year 2007.

Analysis Process

For the first part of this analysis, unadjusted and adjusted risk ratios for the risk factors were computed using the 1-6 months birth interval category as the outcome of interest and the 25-36 months birth interval as the reference category. This interval was used as the reference category based on a preliminary analysis of the data that indicated birth outcomes in this category tended to be better than birth outcomes in the other categories. Risk ratios above one indicate an increased risk for having a 1-6 months birth interval. Interaction between maternal race and the risk of 1-6 months birth interval was also assessed since significant interaction with maternal race has been observed in other birth outcome studies [3].

In the second part of this analysis, relationships between the 1-6 months birth interval and four birth outcomes were examined. The four birth outcomes were: small-for-gestational age (infants whose birthweight was below the tenth percentile of birthweight for births with the same gestational age in weeks), low birth weight (birthweight < 2500 grams), preterm delivery (gestational age < 37 weeks calculated from date of last menses and date of birth), and infant

death (the death of an infant before age 1). Risk ratios above one indicate increased risk for a poor birth outcome for births with a 1-6 months birth interval. The risk ratios were adjusted for maternal race, age, education, tobacco use, marital status, hypertension and/or diabetes, foreign-born status, the presence of the father's name on birth certificate, 7-24 months birth-to-conception interval, and the adverse birth outcomes of first-born infants (low birthweight, preterm delivery and small-for-gestational age and infant death). Interactions between maternal race, birth outcomes and the 1-6 months birth interval were also assessed.

Results

Table 1 shows the counts resulting from the selection criteria as described in the Methods section. Relatively few births were excluded due to missing values for the social security numbers, mother's year of birth, and dates of last menses. Out of 489,078 singleton first births, there were 449,787 or 92.0% with a valid social security number and valid maternal year of birth. 249,657 singleton first births were linked to a singleton second birth. Of these linked first and second births, there were 233,634 or 93.6% with valid dates of last menses.

Table 2 shows the prevalence of the risk factors for short birth intervals and demographic characteristics of the women in the analysis cohort. Unmarried marital status, foreign-born, and maternal race Black were the three factors with the highest prevalence at 36.4%, 20.5% and 19.3% respectively. In comparison, the three factors with the lowest prevalence were infant death of first birth (0.6%), late, no or unknown prenatal care (2.3%) and maternal age > 35 (3.6%).

Table 3 shows the distribution of the linked first and second births in the analysis by birth interval category.

Risk of a Short Birth Interval

Adjusted risk ratios for possibility of having a 1-6 months interval between the birth of a first child and the conception of the second child are shown in Table 4. Separate sets of adjusted risk ratios were computed for Black and White and other race women, because statistically significant interactions were found in this study between many of the analysis factors and maternal race. Testing for significant rate ratio differences between Black and White and other race women was conducted using the method described by Thompson and Zeni [4]. The last column of Table 4 shows significant differences in the risk ratios for Black and White and other race for maternal age < 18, tobacco use; marital status; foreign-born; prenatal care receipt – late, none and unknown; preterm delivery at first birth; and infant death of first birth. Black women who were not born in the U.S. were 11% less likely to have a 1-6 months birth interval as evidenced by the risk ratio of 0.89 (95% CI 0.82 to 0.95). In contrast, White and other race women not born in the U.S. were 21% more likely to have a 1-6 months birth interval as indicated by the risk ratio of 1.21 (95% CI 1.16 to 1.26). In general, more analysis factors were associated with increased risk of short intervals for White and other race women compared to Black women. This may be partially due to lower statistical power for the Black subgroup due to a lower number of women in the Black subgroup (28,604) compared to the White and other race subgroup (119,887).

For this analysis, the constant value produced from generalized linear model regression measures the risk of having a short interval for women with no risk factors. As shown on the last row of Table 4, the constant for Black women is 0.15 and for White and other race women is

0.08 indicating that Black women with no risk factors were 1.9 (95% CI 1.8 to 2.1) times as likely as White and other race women with no risk factors to have a 1-6 months birth interval.

Short Birth to Conception Interval and Associated Adverse Birth Outcomes

Table 5 shows the adjusted and un-adjusted risk ratios associated with a 1-6 months birth to conception interval and four adverse birth outcomes: small-for-gestational age, low birth weight, preterm delivery, and infant death. The risk ratios are shown separately for maternal race Black, maternal race White and other race and overall. After adjusting for covariates as described in the Methods section, the overall risk ratios indicate that birth intervals of 1 to 6 months are associated with increased risk of infant death, low birth weight and small-for-gestational age. Intervals of 1 to 6 months were not associated with increased risk of preterm delivery after adjusting for covariates.

The pattern is different for the race-specific risk ratios in Table 5. For both Black and White and other race women, a 1-6 months birth to conception interval is associated with increased risk of low birth weight infant as shown by the adjusted risk ratios of 1.24 (95% CI: 1.11 to 1.39) and 1.15 (95% CI: 1.05 to 1.27) respectively. For Black women, a 1-6 months birth to conception interval is associated with increased risk of preterm birth at the second birth, but this is not true for White and other race women. The risk ratios are 1.16 (95% CI: 1.07 to 1.26) for Black women and 0.99 (95% CI: 0.93 to 1.05) for White and other race women.

For White and other race women, birth intervals of 1 to 6 months are associated with increased risk of the other two outcomes; *infant death* and *small-for-gestational age* at the second birth. The adjusted risk ratios are 1.45 (95% CI: 1.04 to 2.03) and 1.18 (95% CI: 1.09 to 1.27) respectively. In contrast, the adjusted risk ratios for Black women are not statistically significant for these two outcomes: 1.28 (95% CI: 0.85 to 1.92) and 1.06 (95% CI: 0.96 to 1.17) respectively.

In Table 6, the adjusted and un-adjusted risk ratios for the four birth outcomes are compared for Black and White and other race women. Tests for statistically significant differences between the risk ratios were done using methods described by Thompson and Zeni [4]. Comparing the adjusted risk ratios of Black and White and other race women, only one of the four adverse birth outcomes is statistically significantly different. For the outcome *preterm delivery at second birth*, the adjusted risk ratios for a 1-6 months birth intervals are 1.16 for Black women and 0.99 for White and other race women. As noted in Table 6, the difference between the 1.16 for Black women and the 0.99 for White and other race women is statistically significant.

Discussion and Conclusions

The results of this analysis indicate that a short birth to conception interval (1-6 months) is associated with increased risk of low birth weight, small-for-gestational age, and infant death.

It is worth noting that, in this analysis, women whose first-born infant subsequently died before age 1 (infant death) were more likely to conceive again within 6 months (Table 4). This accounts for part of the increased risk of infant death associated with short intervals since women who have an infant death with the first birth are more likely to have an infant death with the second birth and are also more likely to conceive again within the 6 months after the first birth. However, despite adjusting for the occurrence of an infant death for the first birth, there is an increased risk of infant death for the second birth associated with intervals of 1 to 6 months (Table 5). In summary, women who experience an infant death are more likely to conceive again too soon and thereby increase their already higher risk of experiencing another infant

death. Women that have experienced a death of an infant may require additional educational emphasis on family planning and birth spacing plus counseling to counter the desire to conceive again quickly after a loss of an infant.

This analysis also found that many analysis covariates are associated with a 1-6 months birth intervals between first births and the conception of second births are different for Black and White and other race women. This could be useful information for planning and implementing programs to promote optimal birth spacing.

Limitations

There are several limitations to this study. Birth records that did not have valid social security numbers and year of birth for the mother were excluded from this analysis since these items were necessary to link the first and second births. Approximately 8% of the births were excluded for this reason. Another limitation is the indeterminate level of failed links between first and second births. If women move out of Florida at some time between the first and second birth, and give birth to the second infant in another state, the second birth would not be linked with the first birth and would therefore be excluded from this analysis. Additionally, if women use different social security numbers for the first and second birth, this will cause the link to fail. Since this analysis uses birth record data obtained from the Florida Office of Vital Statistics, it is subject to the completeness and accuracy limitations of the birth registry system. Lastly, there was a lower statistical power to assess the Black subgroup due to a lower number of women in the Black subgroup compared to the White and other race subgroup.

References

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Table 1

Florida Singleton First Births 1998 - 2003 Linked to Second Births

Births	1,217,102
Singleton births	1,160,201
Singleton First Births	489,078
Singleton first births with valid mother SSN and mother year of birth	449,787
Linked to a 2nd birth	249,657
Linked to a 2nd birth with valid LMP* date	233,634
Linked to a 2nd birth with valid LMP date <= 36 months from DOB**	160,133
Linked to a 2nd birth with valid LMP date <= 36 months from DOB and no other pregnancy outcome between births	148,491

*** Last Menstrual Period**
**** Date of Birth**

Table 2

Risk Factor Prevalence
Florida Singleton First Births 1998 - 2003 Linked to Second Births*

Risk Factor	First Births with Factor	Percent of Total First Births
Maternal Race Black	28604	19.3%
Maternal age > 35	5359	3.6%
Maternal age < 18	13429	9.0%
Maternal Education < HS	16271	11.0%
Maternal tobacco use	9840	6.6%
Unmarried	54114	36.4%
Father's name absent on birth certificate	9724	6.5%
Mother not born in US	30461	20.5%
Late, no or unknown prenatal care	3377	2.3%
Maternal Hypertension or Diabetes	11263	7.6%
Birthweight < 2500 grams at first birth	9854	6.6%
Preterm delivery at first birth	15092	10.2%
Small-for-gestational age at first birth	14416	9.7%
Infant death of first birth	858	0.6%

* Excludes linked births with other pregnancy outcome between first and second birth.

Table 3

Florida Singleton First Births 1998 - 2003
Linked to Second Births

Months Between First Birth and LMP date of 2nd Birth	Births	Percent
1 to 6	17,196	11.6%
7 to12	30,740	20.7%
13 to 18	32,973	22.2%
19 to 24	27,977	18.8%
25 to 30	22,236	14.9%
31 to 36	17,657	11.9%
Total	148,779	100.0%
mean	17.9	months
median	17	months

Table 4

Risk Ratios for Birth to Conception Interval of 1 to 6 Months
Florida Singleton First Births 1998 - 2003 Linked to Second Births [1]

	Maternal Race Black		Maternal Race White & Other		
	Adjusted Risk Ratio	95% CI	Adjusted Risk Ratio	95% CI	p Value of Risk ratio Difference
Maternal age > 35	1.04	(0.84 - 1.29)	1.28 *	(1.18 - 1.38)	0.079
Maternal age < 18	1.03	(.096 - 1.11)	1.20 *	(1.13 - 1.28)	0.002 *
Maternal Education < HS	1.38 *	(1.29 - 1.47)	1.48 *	(1.41 - 1.56)	0.079
Maternal tobacco use	1.08	(0.91 - 1.28)	1.31 *	(1.24 - 1.38)	0.036 *
Unmarried	1.01	(0.94 - 1.09)	1.34 *	(1.29 - 1.40)	0.000 *
Father's name absent on birth cert.	1.03	(0.96 - 1.10)	0.97	(0.90 - 1.05)	0.281
Mother not born in US	0.89 *	(0.82 - 0.95)	1.21 *	(1.16 - 1.26)	0.000 *
Late, no or unknown prenatal care	1.10	(0.98 - 1.24)	1.31 *	(1.18 - 1.45)	0.030 *
Maternal Hypertension or Diabetes	1.09	(1.00 - 1.19)	1.00	(0.94 - 1.07)	0.132
Birthweight < 2500 grams at first birth	1.08	(0.98 - 1.19)	1.07	(0.99 - 1.15)	0.868
Gestational age < 37 weeks at first birth	0.99	(0.91 - 1.08)	1.13 *	(1.06 - 1.20)	0.014 *
Small for gestational age at first birth	1.01	(0.93 - 1.09)	1.09 *	(1.03 - 1.16)	0.100
Infant death of first birth	1.60 *	(1.30 - 1.98)	2.55 *	(2.21 - 2.93)	0.000 *
Constant	0.15	(0.14 - 0.16)	0.08	(0.08 - 0.08)	0.000 *

n = 148,491

* Statistically significant at alpha level 0.05

[1] Excludes linked births with other pregnacy outcome between first and second birth.

Table 5

Birth Outcome Risk Ratios for Birth to Conception Interval of 1 to 6 Months
Compared to Interval of 25 to 36 months (reference)
For Birth Outcomes at Second Birth
Florida Singleton First Births 1998 - 2003 Linked to Second Births

Birth Outcome	Adjusted** Risk ratio		95% C.I. Lower	Upper	Un-Adjusted Risk ratio		95% C.I. Lower	Upper
Maternal Race Black								
Birthweight < 2500 grams at second birth	1.24	*	1.11	1.39	1.34	*	1.19	1.50
Gestational age < 37 weeks at second birth	1.16	*	1.07	1.26	1.20	*	1.11	1.31
Infant death of second birth	1.28		0.85	1.92	1.55	*	1.05	2.31
Small for Gestational age at second birth	1.06		0.96	1.17	1.15	*	1.04	1.26
Maternal Race White and other races								
Birthweight < 2500 grams at second birth	1.15	*	1.05	1.27	1.36	*	1.24	1.51
Gestational age < 37 weeks at second birth	0.99		0.93	1.05	1.08	*	1.01	1.15
Infant death of second birth	1.45	*	1.04	2.03	1.86	*	1.33	2.59
Small for Gestational age at second birth	1.18	*	1.09	1.27	1.37	*	1.27	1.48
Overall								
Birthweight < 2500 grams at second birth	1.19	*	1.10	1.28	1.48	*	1.37	1.59
Gestational age < 37 weeks at second birth	1.04		0.99	1.09	1.17	*	1.11	1.23
Infant death of second birth	1.41	*	1.09	1.82	1.89	*	1.46	2.43
Small for Gestational age at second birth	1.13	*	1.07	1.20	1.37	*	1.29	1.45

n = 148,491

*** Statistically significant at alpha = 0.05**

**** Adjusted for: maternal race, age, education, tobacco use, marital status, presence of father's name on birth certificate, non-US born mother, maternal hypertension or diabetes, birth to conception time of 7 to 24 months, first birth outcomes: birthweight < 2500 grams, gestational age < 37 weeks, small for gestational age and infant death**

Table 6

Birth Outcome Risk Ratios By Maternal Race
for Birth to Conception Interval of 1 to 6 Months
Compared to Interval of 25 to 36 months (reference)
For Birth Outcomes at Second Birth
Florida Singleton First Births 1998 - 2003 Linked to Second Births

Birth Outcome	Maternal Race Black Adjusted** Risk ratio	Maternal Race White & other Adjusted** Risk ratio	Risk ratio Difference	P value of Risk ratio Difference P Value	
Birthweight < 2500 grams at second birth	1.24	1.15	0.09	0.266	
Gestational age < 37 weeks at second birth	1.16	0.99	0.17	0.002	*
Infant death of second birth	1.28	1.45	-0.17	0.524	
Small for Gestational age at second birth	1.06	1.18	-0.12	0.069	

Birth Outcome	Un-Adjusted Risk ratio	Un-Adjusted Risk ratio	Difference	P Value	
Birthweight < 2500 grams at second birth	1.34	1.36	-0.03	0.781	
Gestational age < 37 weeks at second birth	1.20	1.08	0.13	0.037	*
Infant death of second birth	1.55	1.86	-0.30	0.502	
Small for Gestational age at second birth	1.15	1.37	-0.22	0.005	*

*** Statistically significant at alpha = 0.05**