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ARTICLE

Effect of interpregnancy interval on birth outcomes: findings from three recent US studies

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Abstract

The relationship between interpregnancy interval and adverse birth outcomes (i.e., low birth weight, preterm birth, and small size for gestational age) was examined in three recent studies conducted in Utah and Michigan of the United States. These studies were conducted among different populations, used different study designs (i.e., cross-sectional and retrospective cohort designs), and addressed several other methodological limitations in the previously published literature. In addition, the data were stratified by, and controlled for, several maternal reproductive risk factors. A J-shaped relationship between interpregnancy interval and adverse birth outcomes was observed in all three studies. The risk for adverse birth outcomes is lowest when the interpregnancy interval was 18—23 months and increased when the interval departed from 18—23 months. This J-shaped relationship existed at levels of maternal reproductive risk factors and after these risk factors were controlled for using logistic regression. Based on the consistency of the findings from all three studies, it appears that the J-shaped relationship between interpregnancy interval and adverse birth outcomes is causal. This information can be used by health care providers and public health programs to counsel and educate women who recently gave births on reducing the risk for adverse birth outcomes by means of appropriate pregnancy spacing.

"*If two or more instances of the phenomenon under investigation have only one circumstance in common, the circumstance in which alone all the instances agree is the cause (or effect) of the given phenomenon.*"—John Stuart Mill [1]

1. Introduction

Low birth weight and preterm birth combined are the second leading cause of death for all U.S. infants, and the leading cause of death for African-American infants [2—5]. In addition, low birth weight and preterm birth may lead to serious and costly sequelae, such as cerebral palsy, for the

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affected infant. Little progress has been made in recent years in reducing the prevalence of low birth weight and preterm birth. In fact, during the past two decades, the prevalence of low birth weight and preterm birth in the U.S. has steadily increased [6]. Although many studies have been conducted on the causes of low birth weight and preterm birth, the etiology remains largely unknown.

Since the early 1920s, many researchers have investigated the relationship between pregnancy spacing (i.e., the time lapsed between two consecutive pregnancies) and various adverse birth outcomes, including low birth weight, preterm birth, small size for gestational age, and infant mortality. Most studies have found that a short interpregnancy interval was associated with increased risk for various adverse birth outcomes [7–13]. However, a review of the literature revealed a number of methodological limitations in previously published literature. First, many earlier studies used birth interval (i.e., the time between two consecutive live births) to measure pregnancy spacing. It has been demonstrated that using birth interval overestimates the adverse effect of very short birth intervals [8]. Therefore, interpregnancy interval is preferred over birth interval in this kind of research. Second, extreme interpregnancy intervals (e.g., <3 months or >10 years) are rare. Thus a large sample size, which most of the previously published studies lacked, is needed to study their effects. Third, many maternal reproductive risk factors are associated with both interpregnancy interval and adverse birth outcomes. The potential confounding effect of these risk factors needs to be carefully examined through stratified and multivariable analyses. However, many of the previously published studies lacked the sample size to perform detailed stratified and multivariable analyses. Fourth, most of the previously published studies arbitrarily categorized interpregnancy interval into "short" and "non-short," using various cutoff points (e.g., <3, <6, <9, or <12 months). As will be seen later in this paper, the underlying association between interpregnancy interval and adverse birth outcomes is J-shaped; hence such arbitrary categorization of the interpregnancy interval may underestimate the risk of short interpregnancy interval. Therefore, one needs to examine the association over the entire range of interpregnancy interval. Fifth, most of the previously published studies used cross-sectional design. The findings of those studies need to be verified using the longitudinal design. Sixth, many studies used the combined birth records data in the same jurisdiction over several years. These data contain birth records for siblings born to the same biological mother, which are correlated with each other. Therefore, appropriate statistical techniques are needed to account for this correlation [14,15].

Those methodological limitations in the published literature have led many researchers to suspect that the association between interpregnancy interval and adverse birth outcomes may be artificial. Therefore, the author of this paper, in collaboration with his colleagues, conducted a series of three studies in various settings and used different study designs (Table 1). This paper summarizes the findings of those studies.

2. The Utah Study [16]

The first study was conducted in Utah [16]. The study used the birth certificate data for singleton infants born during 1989–1996 to multiparous Utah women (i.e., those who had at least one previous live birth). The study examined three adverse birth outcomes—low birth weight (<2500 g), preterm birth (gestational age <37 weeks), and small size for gestational age (birth weight <10th percentile for the infant's gestational age and sex compared with all singleton births in Utah from 1989 to 1996). The interpregnancy interval was defined as the period between the delivery of a live birth and the conception of the subsequent live birth, and was computed as the interval between two consecutive deliveries minus the gestational age of the second infant. To examine the question whether the relationship was due to confounding, 16 maternal reproductive risk factors were evaluated: Maternal age at delivery, outcome of the most recent recognized pregnancy, number of previous live-born infants who were still alive, number of previous live-born infants who had died, number of previous spontaneous or induced abortions, height, prepregnancy weight, weight gain during pregnancy, trimester at which prenatal care was started, number of prenatal care visits, marital status, education, race or ethnic group, residence (rural or urban), tobacco use during pregnancy, and alcohol use during pregnancy.

These data offered an excellent opportunity for evaluating the relationship between interpregnancy intervals and adverse birth outcomes because of the relatively high average parity of mothers in Utah. Also, the association can be examined with less potential for confounding because other reproductive risk factors, notably tobacco and alcohol use, are substantially less prevalent among Utah women than among women elsewhere in the U.S. The relationship between

Table 1 Summary of three recent U.S. studies on the effect of interpregnancy interval on birth outcomes

Study	Sample size	Study design	Adverse birth outcomes examined[a]	Use of IPI vs. BI[b]	Other maternal risk factors examined	Main conclusions	Comments
Utah Study (1999) [16]	173,205 singleton live births to multiparous women in Utah, 1989–1996	Cross-sectional study	LBW; PTB; SGA[c]	Used IPI; 0–5; 6–11; 12–17; 18–23; 24–59; 60–119; 120+ months	Age at delivery; outcome of preceding pregnancy; no. of previous infants still alive; no. of previous infants deceased; no. of previous spontaneous or induced abortions; height; prepregnancy weight; weight gain during pregnancy; trimester prenatal care started; no. of prenatal care visits; marital status; education; ethnicity; rural or urban residence; tobacco/alcohol use during pregnancy.	The optimal IPI appears to be 18–23 months; both short and long IPIs were associated with increased risk for adverse birth outcomes; risk increased in a linear fashion as IPI departs from optimal IPI in either direction; the association between IPI and adverse birth outcomes was not due to confounding by other risk factors.	Used vital records data in the same state compiled over several years; unable to examine the relationship by race.
Michigan Cross-Sectional Study (2001) [17]	435,327 singleton live births (346,250 to white women, 89,077 to black women), Michigan, 1993–1998	Cross-sectional study	LBW; PTB; SGA[d]	Used IPI; 0–5; 6–11; 12–17; 18–23; 24–59; 60–119; 120+ months	Race (white, black); age at delivery; marital status; education; adequacy of prenatal care; outcome of the preceding pregnancy (live birth or stillbirth); total number of previous pregnancies; tobacco/alcohol use during pregnancy.	Upheld findings of the Utah Study; an IPI of 18–23 months was optimal for both white and black women; risk for adverse birth outcomes increased appreciably when IPI was <6 months or >5 years.	Data were analyzed separately by race; used vital records data in the same state compiled over several years.
Michigan Retrospective Cohort Study (2003) [20]	565,911 singleton live births to Michigan women, 1993–2000, linked to biological mothers	Retrospective cohort study using maternally linked birth data	LBW (data on PTB and SGA available but not published)	<6; 6–11; 12–17; 18–23; 24–59; 60–95; 96–136 months	Preceding infant's birth weight; mother's age, race, education, prenatal care utilization, tobacco/alcohol use during pregnancy; outcome of preceding pregnancy; number of previous live births; paternal acknowledgment on the birth certificate.	Upheld findings from the Utah Study and Michigan Cross-Sectional Study; population attributable risk (PAR)=9.4% if optimal IPI is defined as 18–23 months; PAR=5.1% if optimal IPI is defined as 6–59 months.	Data were analyzed separately by pairs of births. Stratified by, and controlled for birth weight of preceding sibling.

[a] LBW=low birth weight; PTB=preterm birth; SGA=small-for-gestational-age birth.
[b] IPI: interpregnancy interval; BI: birth interval.
[c] SGA=birth weight below the 10th percentile for the infant's gestational age and sex among singleton births in Utah from 1989 to 1996.
[d] SGA=birth weight <10th percentile of the referent population of U.S. newborns for the infant's gestational age, race, sex, and parity [18].

interpregnancy interval and the three adverse birth outcomes was examined at each level of the 16 maternal risk factors. In addition, the logistic regression technique was used to simultaneously control for all 16 risk factors.

A total of 173,205 singleton infants were included in the study. When the risk for the three adverse birth outcomes was examined according to interpregnancy interval, a J-shaped pattern emerged: The risk for all three outcomes was high when the interpregnancy interval was very short (e.g., <3 months). The risk declined sharply as the interpregnancy interval increased, and reached the lowest point when the interpregnancy interval was approximately 18—23 months. After that point, the risk for all three adverse birth outcomes slowly increased in a linear fashion as the interpregnancy interval further increased. This J-shaped pattern was observed at each level of the 16 maternal reproductive risk factors wherever data were sufficient to support the stratified analysis. (Fig. 1 shows the relationship between interpregnancy interval and low birth weight in all three U.S. studies. Although not shown in the figure, the relationship between interpregnancy interval and the other two adverse birth outcomes is similar.)

When all 16 maternal reproductive risk factors were simultaneously controlled for, the J-shaped pattern persisted. For example, as compared with an interpregnancy interval of 18—23 months, the adjusted odds ratios for an interpregnancy interval shorter than 6 months were 1.4 for low birth weight, 1.4 for preterm birth, and 1.3 for small size for gestational age; the adjusted odds ratios for an interpregnancy interval of 120 months or longer were 2.0 for low birth weight, 1.5 for preterm birth, and 1.8 for small size for gestational age (Table 2).

The Utah Study addressed several methodological limitations in previously published studies. It used the interpregnancy interval instead of the birth interval. Also, it assembled the birth records of a large number of infants, enabling the researchers to perform extensive stratified and multivariable analyses. Additionally, it examined the association over the full range of interpregnancy interval rather than arbitrarily categorizing the interpregnancy interval into "short" and "non-short" intervals. However, several issues remained unaddressed. The study was based on a cross-sectional design using a data set compiled of the birth records in Utah over 8 years, and the correlation between biological siblings was not appropriately accounted for. Concerns were also raised by other researchers as to whether a study con-

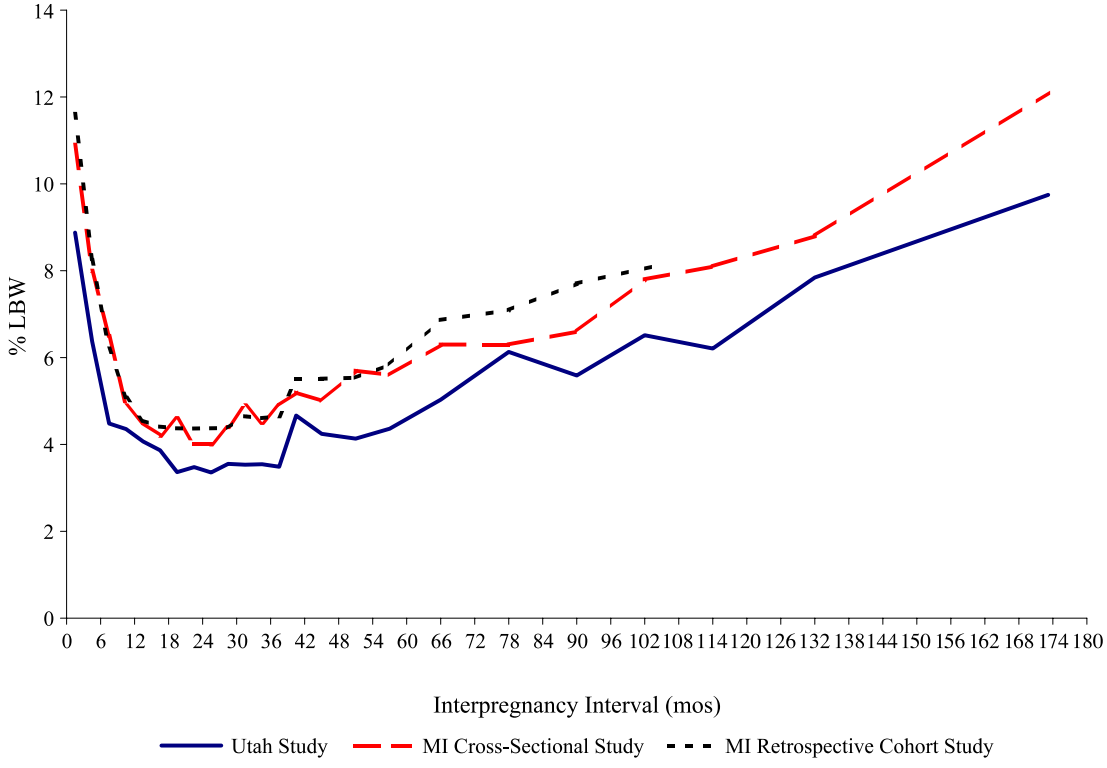

Figure 1 Relationship between interpregnancy interval and low birth weight (LBW): summary of three recent U.S. studies [16,17,20].

Table 2 Adjusted odds ratios (OR) of adverse birth outcomes and their 95% confidence intervals (CI) associated with various interpregnancy intervals from two cross-sectional studies conducted in Utah [16] and Michigan [17]

Interpregnancy interval (months)	Low birth weight[a]		Preterm birth[a]		Small size for gestational age[b]	
	OR	95% CI	OR	95% CI	OR	95% CI
Utah Study[c]						
0–5	1.4	1.3–1.6	1.4	1.3–1.5	1.3	1.2–1.4
6–11	1.1	1.0–1.2	1.0	0.9–1.1	1.1	1.0–1.2
12–17	1.1	1.0–1.2	1.0	0.9–1.1	1.1	1.0–1.1
18–23	referent		referent		referent	
24–59	1.1	1.0–1.1	1.0	0.9–1.1	1.1	1.1–1.2
60–119	1.5	1.3–1.6	1.1	1.0–1.2	1.4	1.3–1.5
120+	2.0	1.7–2.4	1.5	1.3–1.7	1.8	1.6–2.0
Michigan Cross-Sectional Study[d]						
White						
0–5	1.5	1.4–1.6	1.3	1.2–1.4	1.3	1.3–1.4
6–11	1.1	1.0–1.2	1.2	1.1–1.2	1.1	1.1–1.2
12–17	1.0	1.0–1.1	1.1	1.0–1.1	1.0	1.0–1.1
18–23	referent		referent		referent	
24–59	1.1	1.0–1.2	1.0	1.0–1.1	1.1	1.1–1.2
60–119	1.3	1.2–1.4	1.2	1.1–1.2	1.3	1.3–1.4
120+	1.9	1.7–2.1	1.4	1.3–1.5	1.7	1.6–1.8
Black						
0–5	1.5	1.3–1.6	1.2	1.1–1.3	1.3	1.2–1.4
6–11	1.2	1.1–1.3	1.1	1.1–1.2	1.1	1.0–1.3
12–17	1.0	0.9–1.1	1.0	1.0–1.1	1.0	0.9–1.1
18–23	referent		referent		referent	
24–59	1.0	1.0–1.1	0.9	0.9–1.0	1.1	1.0–1.2
60–119	1.2	1.1–1.3	1.0	0.9–1.1	1.1	1.0–1.2
120+	1.6	1.4–1.7	1.3	1.2–1.4	1.4	1.2–1.6

[a] Low birth weight=birth weight <2500 g; preterm birth=gestational age <37 weeks.
[b] Small size for gestational age: In Utah Study was defined as birth weight <10th percentile for infant's gestational age and sex among singleton birth in Utah from 1989 to 1996; in Michigan Cross-Sectional Study was defined as birth weight <10th percentile of referent population of U.S. newborns for the infant's gestational age, race, sex, and parity [18].
[c] Controlled for maternal age at delivery, outcome of most recent recognized pregnancy, number of previous live-born children who were still alive, number of previous live-born children who had died, number of previous spontaneous or induced abortions, height, weight before pregnancy, weight gain during pregnancy, trimester when prenatal care started, number of prenatal care visits, marital status, education, race or ethnic group, rural or urban residence, tobacco use during pregnancy, and alcohol use during pregnancy.
[d] Controlled for maternal age at delivery, marital status, education, adequacy of prenatal care, outcome of the preceding birth (live birth or still birth), total number of previous pregnancies, tobacco use during pregnancy, and alcohol use during pregnancy.

ducted in a largely homogeneous, mostly white middle-income population can be generalized to other populations. Of special concern was the unavailability of data on whether the relationship between interpregnancy interval and adverse birth outcomes among other racial and ethnic groups differed from that among white non-Hispanics.

3. The Michigan Cross-Sectional Study [17]

The Michigan Cross-Sectional Study [17] was designed to address the questions on whether the Utah Study was generalizable to other populations, and whether there was any racial differences in the relationship between interpregnancy interval and adverse birth outcomes. The three adverse birth outcomes examined in this study were the same as in the Utah Study: Low birth weight (<2500 g), preterm birth (gestational age <37 weeks); and small-for-gestational-age birth, which was defined as birth weight <10th percentile of the referent population of U.S. newborns for the infant's gestational age, race, sex, and parity [18]. Of note, this definition used the U.S. national population as the reference population, which is slightly different from that in the Utah Study; the latter used the internal Utah population as the reference.

The population in Michigan is more similar to the general U.S. population than the Utah population. Also, there is a sizable (approximately 18%) African-American population in Michigan, enabling the researchers to examine the relationship between

interpregnancy interval and adverse birth outcomes among both white and African-American women. The study compiled the birth records of 435,927 singleton infants born in Michigan during 1993—1998 to multiparous white and African-American women. Separate analyses were performed for white (N=346,250) and African-American (N=89,077) women. Within each racial group, the relationship between interpregnancy interval and adverse birth outcomes was examined at each level of eight maternal reproductive risk factors: age at delivery, marital status, education, adequacy of prenatal care, outcome of the preceding pregnancy (i.e., live birth or stillbirth), total number of previous pregnancies, tobacco use during pregnancy, and alcohol use during pregnancy.

All three adverse birth outcomes were more prevalent among newborns in Michigan than among those in Utah because the percent of African-American women was higher in Michigan than in Utah, and infants born to African-American women are at greater risk for adverse birth outcomes [19]. However, the relationship between interpregnancy interval and adverse birth outcomes was very similar in the Michigan Cross-Sectional Study as compared to that in the Utah Study. (Fig. 1 shows the relationship between interpregnancy interval and low birth weight in the three studies.) Both short and long interpregnancy intervals were associated with an increased risk for adverse birth outcomes. When the association was examined for white and African-American women separately, the J-shaped relationship between interpregnancy interval and the three adverse birth outcomes existed in both racial groups. Moreover, the J-shaped relationship persisted at each level of other maternal reproductive risk factors within each racial group, and after controlling for those risk factors simultaneously by logistic regression (Table 2).

The Michigan Cross-Sectional Study observed a similar J-shaped relationship in a population resembling the average population in the U.S., and among both white and African-American women. Therefore, the findings from the Utah Study appeared to be generalizable to other populations. However, both the Michigan Cross-Sectional Study and the Utah Study were based on compiled vital records data registered in the same state over several years. Both data sets likely contained many sets of siblings born to the same biological mothers. The data for these siblings are statistically correlated. Theoretically, this type of cross-sectional study designs may produce correct point estimates of the risks and odds ratios. However, the estimated variances, as well as the resulting confidence interval estimates as well as statistical inferences, may be incorrect [14,15].

4. The Michigan Retrospective Cohort Study [20]

The Michigan Retrospective Cohort Study [20] was designed to verify the findings from the Utah Study and the Michigan Cross-Sectional Study, and to address the statistical problem regarding the correlation among biological siblings in the data. The published paper only included data on the relationship between interpregnancy interval and low birth weight (<2500 g). The researchers also examined preterm birth and small size for gestational age in relation to interpregnancy interval, and found similar results in comparison with the findings regarding low birth weight. These data are available from the author of this paper upon request.

The data for the Michigan Retrospective Cohort Study were the birth records for infants born in Michigan and out of state births to Michigan resident women between January 1, 1989 and December 31, 2000. The data for the infants born to the same biological mother were linked, using the mother's social security number, first name, last name, middle initial, maiden name, and birth date. When a link is in question, the mother's address, the infant's birth date, and other information on the birth certificate were used for verification.

By linking the birth records of the infants born to the same biological mother, the reproductive histories of cohorts of women who delivered live births in Michigan from 1989 to 2000 were re-created. This design allowed the researchers to conduct retrospective cohort analyses, and verify the findings from the previously published cross-sectional studies. Also, because the researchers were able to identify the biological siblings through this design, they were able to use appropriate statistical techniques to address the statistical problems caused by the correlation among the siblings in the data. Additionally, this approach enabled the researchers to calculate the interpregnancy interval directly from the recorded birth dates of two consecutive live births rather than relying on the self-reported date of the previous live birth; thus, the accuracy of the estimated interpregnancy interval was improved. Moreover, the researchers were able to evaluate and control for the birth weight of the preceding sibling. Previously, researchers have raised concerns about the potential confounding effect of this variable,

because it is a powerful predictor for the birth weight of the subsequent sibling.

The overall relationship between interpregnancy interval and low birth weight was examined. The data were then stratified into pairs of births by the birth order of the biological siblings (i.e., first-second, second—third, third—fourth, and forth—fifth), and the relationship was examined by pairs of births. The potential confounding effect of other reproductive risk factors was examined through stratified and multivariable analysis within the pairs of births.

The birth records of 565,816 infants born during 1989 and 2000 in Michigan who had at least one biological sibling born during the same time period in Michigan or to a Michigan resident woman were identified and linked to their biological mothers. These infants were born to 422,590 mothers, of whom 79.6% were whites, 18.2% were African-Americans, 1.3% were Asians or Pacific Islanders, 0.5% were Native Americans, and 0.4% were women of other racial groups or whose racial group was not identified on the birth certificate. A similar J-shaped relationship between interpregnancy interval and low birth weight was found overall (Fig. 1), and among both white and African-American women in this study. When the data were stratified by pairs of birth, a J-shaped relationship existed among the first—second, second—third, third—fourth, and forth—fifth pairs of births, and persisted after controlling for other risk factors, most notably the birth weight of the preceding sibling (Table 3). Also, the study estimated the adjusted population attributable risk for low birth weight due to "non-optimal" interpregnancy intervals. It was found that the adjusted population attributable risk was 5.1% if the optimal interpregnancy interval was defined as 6—59 months, and 9.4% if the optimal interval was defined as 18—23 months.

5. Discussion

The three studies conducted in various populations, using different study designs, stratified by, and controlling for various maternal reproductive risk factors addressed a number of methodological limitations regarding previously published studies. It was gratifying to observe a consistent J-shaped relationship between interpregnancy interval and adverse birth outcomes in all three studies. It is noteworthy that all three studies meticulously stratified the data by 5-year maternal age groups. A J-shaped relationship between interpregnancy interval and adverse birth outcomes persisted in all age groups wherever the data supported the stratified analysis. Hence these studies adequately demonstrated that the relationship between a long interpregnancy interval and adverse birth outcomes is not due to confounding by maternal age. Therefore, short of a proof from a randomized controlled trial, one may conclude, with due caution, that there is a causal relationship between interpregnancy interval and adverse birth outcomes. The optimal interpregnancy interval for preventing adverse birth outcomes appeared to be approximately 18—23 months, departing from which the risk for adverse birth outcomes increased, although the increase was not appreciable unless the interpregnancy interval was shorter than 6 months or longer than 5 years.

Prior to these studies, researchers had mostly examined the relationship between a short interpregnancy interval (albeit arbitrarily defined) and the risk for adverse birth outcomes, and proposed various theories about the mechanisms to explain the relationship. The most widely accepted theories involved postpartum nutritional depletion (especially folate deficiency) and stress [21—23].

Two hypotheses were proposed to explain the relationship between a long interpregnancy inter-

Table 3 Adjusted[a] odds ratios (OR) of low birth weight (<2500 g) and their 95% confidence intervals (CI) associated with various interpregnancy intervals, by birth pairs, from the Michigan Retrospective Cohort Study [19]

Interpregnancy interval (months)	First—second birth pairs		Second—third birth pairs		Third—fourth birth pairs		Fourth—fifth birth pairs	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
<6	1.4	1.3—1.5	1.5	1.3—1.6	1.2	1.1—1.4	1.3	1.1—1.6
6—11	1.1	1.0—1.1	1.1	1.0—1.2	1.0	0.9—1.2	1.0	0.9—1.3
12—17	1.0	0.9—1.1	1.0	0.9—1.1	1.0	0.8—1.1	1.0	0.8—1.3
18—23	referent		referent		referent		referent	
24—59	1.1	1.0—1.1	1.1	1.0—1.1	1.0	0.9—1.1	1.1	1.0—1.4
60—95	1.5	1.3—1.6	1.3	1.2—1.4	1.3	1.1—1.5	1.2	0.9—1.5
96—136	1.5	1.3—1.8	1.6	1.3—2.0	1.4	1.0—2.0	1.3	0.8—2.3

[a] Controlled for the preceding infant's birth weight, paternal acknowledgment on birth certificate, mother's age at delivery, race, education, adequacy of prenatal care utilization, outcome of preceding pregnancy (live birth, stillbirth), tobacco use and alcohol use during pregnancy.

val and adverse birth outcomes by the researchers of the three studies [16,17,20]. One is the "physiological regression hypothesis," i.e., the mother's physiologic processes are primed for fetal growth during pregnancy. This benefit gained during pregnancy would decline gradually postpartum if the mother is not pregnant again. This hypothesis is supported by the observation that perinatal outcomes for infants conceived after an excessively long interpregnancy interval are similar to outcomes of infants born to primigravid women [16]. Another hypothesis is that the increased risk of adverse perinatal outcomes after a long interpregnancy interval is due to reproductive wastage, i.e., long interpregnancy intervals may involve factors that cause both secondary infertility and adverse perinatal outcomes.

An interesting point of note is that the median interpregnancy interval in all three studies and among all racial groups was approximately 20 months, which coincides with the optimal interval associated with the lowest risk for adverse birth outcomes (18—23 months). These findings suggest that there may be adaptive advantages for the humans to space their pregnancies for approximately 20 months.

Although these three studies have made some advancement in understanding the relationship between interpregnancy interval and adverse birth outcomes, there are still many unanswered questions. For example, more studies are needed on the effects of interpregnancy interval on infant mortality, especially in developing nations. Additionally, more research is needed to understand the relationship between interpregnancy interval and other health outcomes, e.g., maternal morbidity and mortality, and long-term health and development (including physical, behavioral, social, and intellectual development) of the children affected. Also, studies are needed on whether the effects of interpregnancy interval differ between developing and developed nations. On a methodological note, researchers should consider unifying the categorization of interpregnancy interval in their studies to facilitate comparison between studies and meta-analysis. Journals which publish such studies and their reviewers can play an important role in this respect by discouraging the practice of arbitrarily categorizing the interpregnancy interval into "short" and "non-short" interpregnancy intervals, and encouraging researchers to examine the relationship over the full spectrum of the interpregnancy interval.

The findings of these three studies suggest various strategies for preventing adverse birth outcomes through pregnancy spacing. For example, health care providers, especially obstetricians, gynecologists, family practice physicians, pediatricians, nurses, and midwives could use the information from these studies to counsel women who have recently given birth about the risk of delivering infants with adverse birth outcomes if the pregnancies are spaced excessively short or long. Public health programs serving low-income, minority, immigrant, and other vulnerable populations of women could consider developing educational materials about the benefit of optimal pregnancy spacing, and referring clients to family planning services.

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