Distribution Agreement

In presenting this thesis or dissertation as a partial fulfillment of the requirements for an advanced degree from Emory University, I hereby grant to Emory University and its agents the non-exclusive license to archive, make accessible, and display my thesis or dissertation in whole or in part in all forms of media, now or hereafter known, including display on the world wide web. I understand that I may select some access restrictions as part of the online submission of this thesis or dissertation. I retain all ownership rights to the copyright of the thesis or dissertation. I also retain the right to use in future works (such as articles or books) all or part of this thesis or dissertation.

Signature:

_____ _____

Lindsey Haeger Date

Pregnancy Intendedness and Interpregnancy Interval

By

Lindsey Haeger

Master of Science in Public Health

Global Epidemiology

_____

Dr. Michael Kramer

Committee Chair

Pregnancy Intendedness and Interpregnancy Interval

By

Lindsey Haeger

BSFS, Georgetown University, 2004

Thesis Committee Chair: Michael R. Kramer, PhD

An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Science in Public Health
in Global Epidemiology
2012

Abstract

Pregnancy Intendedness and Interpregnancy Interval

By Lindsey Haeger

Background. Short or long interpregnancy interval (IPI) is associated with adverse perinatal outcomes. It is not clear whether pregnancy intendedness is associated with non-optimal IPI or if both unintended pregnancy and non-optimal IPI are caused by common sociodemographic factors.

Methods. Using cross-sectional data from the Georgia Pregnancy Risk Assessment Monitoring System (PRAMS) from 2004-2008 (n=3,133), multivariate logistic and polytomous regression models were used to calculate odds ratios (ORs) for non-optimal (<18 or >59 months), short (<18 months), and long (>59 months) IPI by pregnancy intention status (mistimed, unwanted, or ambivalent, compared to intended). ORs adjusting for maternal age, race/ethnicity, marital status, and education were calculated.

Results. 49.5% of births occurred after a non-optimal IPI. 31.6% and 17.9% of births occurred after short and long IPIs, respectively. A non-optimal IPI was more likely to occur after an unintended pregnancy (OR 1.80, 95% confidence interval (CI) 1.40, 2.31). A short IPI was more likely to occur after a mistimed (OR 2.89, 95% CI 1.95, 4.29), unwanted (OR 2.28, 95% CI 1.46, 3.55), or ambivalent pregnancy (OR 2.11, 95% CI 1.50, 2.96). Long IPI had a weak and non-significant association with unintended pregnancy (OR 1.14, 95% CI 0.80, 1.60).

Conclusion. The findings suggest that short IPI is associated with unintended pregnancy, even when controlling for sociodemographic factors. Long IPI appears to be associated with other factors beyond pregnancy intendedness. The findings have implications for future research on the health outcomes associated with short IPI as well as the causes of long IPI.

Pregnancy Intendedness and Interpregnancy Interval

By

Lindsey Haeger

BSFS, Georgetown University, 2004

Thesis Committee Chair: Michael R. Kramer, PhD

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Science in Public Health
in Global Epidemiology
2012

TABLE OF CONTENTS

CHAPTER I: BACKGROUND

Introduction

It is well established that non-optimal interpregnancy interval (IPI) is associated with adverse perinatal outcomes such as preterm birth, low birth weight, and small size for gestational age, and it may also be associated with adverse maternal outcomes. Pregnancy intendedness is thought to affect maternal and perinatal outcomes through non-optimal IPI as well as other mechanisms. Pregnancy intendedness is a complicated concept based in varying sociocultural norms whose definition has provoked much discourse. It is unclear whether pregnancy intendedness is causally associated with short interpregnancy interval or if both short pregnancy interval and unintended pregnancy occur as a result of similar sociocultural influences. Likewise, questions remain about whether non-optimal pregnancy interval causes adverse pregnancy outcomes or whether the relationship is an artifact of other exposures related to interpregnancy interval.

This paper will investigate whether pregnancy intendedness is associated with non-optimal interpregnancy interval, controlling for shared sociocultural and other factors. It will also investigate whether this association differs between groups. The findings of this research could impact public health programming in the prevention of adverse perinatal outcomes. The findings of this research will also contribute to a better understanding of the mechanisms through which non-optimal interpregnancy intervals occur.

Background

Interpregnancy interval

IPI has gained importance as an important public health issue associated with adverse health outcomes. In 2002, the most recent year for which national level data is available, 21% of United States births occurred within 24 months of a previous birth (1), meaning that, according to that definition of short IPI, at least one fifth of United States births occurred after a short interpregnancy interval. A different definition of short interpregnancy interval typically used in studies of health outcomes is IPI< 18 months. State-level prevalence estimates include 42.1% of

births after an IPI<18 months in Michigan in 2007, 32% of second births to low-risk white women in Georgia with an IPI<18 months, and 33.7% of second births to low-risk black women in Georgia with an IPI<18 months. IPI has been included in the United States Healthy People 2020 objectives, with a goal of reducing the proportion of pregnancies conceived within 18 months of a previous birth from 35.3% in 2006-2008 to 31.7% in 2020 (2).

Various measures of birth spacing exist, including interpregnancy interval (time between one birth and the subsequent conception), birth interval (time between the index birth and the subsequent birth), and interconception interval (time between the conception of the index birth and the subsequent birth). The use of birth interval to measure birth spacing is said to overestimate the risk of adverse perinatal outcomes for very short intervals between pregnancies (3). It is generally agreed that IPI is the best measure of birth spacing to use in studies of health outcomes, as it avoids confounding by preterm birth which could be present when using birth intervals (4). IPI is also easier to obtain than data on conceptions only, which may end in fetal loss and therefore remain undocumented. While the use of different measures of birth spacing and heterogeneous classifications of intervals complicates interpretation of studies on the effects of IPI on maternal and perinatal outcomes, sufficient studies and reviews have been conducted to draw conclusions on the nature of the relationship.

Interpregnancy interval and health outcomes

For at least 50 years, an observed association between short IPIs and adverse perinatal outcomes has been recorded (5). While doubt remains about whether adverse perinatal outcomes are associated with inadequate IPI or whether the relationship is simply due to confounding or unmeasured factors (6), it is generally accepted that both short and long IPIs are linked to adverse perinatal outcomes including preterm birth, low birth weight, and small size for gestational age.

Studies have shown a J-shaped curve of risk for preterm birth, low birthweight, and small size for gestational age according to IPI (7, 8). This relationship persists when adjusted for other

reproductive risk factors and non-independence of siblings, i.e., the increased risk of low birthweight in a subsequent birth associated with low birthweight at the index birth.

Based on perinatal outcomes, it is generally agreed that an IPI of 18-23 months is ideal (8). Two cross-sectional studies of women in Utah and Michigan found that all IPI groups greater or less than the ideal IPI of 18-23 months had a higher risk of preterm birth, low birthweight, and small size for gestational age (7). A retrospective cohort study of women in Michigan showed similar results when adjusting for birth order pairing (7).

A meta-analysis of 67 studies on the relationship between IPI and adverse perinatal outcomes found an increased risk of preterm birth, low birthweight, and small size for gestational age with all IPI groups shorter than 18-23 months (<6 months, 6-11 months, 12-17 months). It also showed increased risk of preterm birth, low birthweight, and small size for gestational age among IPI group ≥60 months, and non-significant associations between the same three outcomes among the IPI group 24-59 months (3). The same meta-analysis showed a dose-response relationship for increased risk of preterm birth, low birthweight, and small size for gestational age with each month of IPI less than 18 months or greater than 59 months.

The relationship between IPI and more extreme perinatal outcomes such as fetal and early neonatal death has not been well established, but existing evidence suggests a possible relationship between these outcomes and more extreme IPIs such as those less than 6 months or greater than 50 months (3).

The cause of the association between IPI and adverse perinatal outcomes is not well understood. It has been hypothesized that pregnancy could deplete maternal stores of nutrition during the index pregnancy which have not been replenished by the conception of the subsequent pregnancy when the IPI is too short (8). It has also been hypothesized that the association between short IPI and adverse perinatal outcomes is due to the fact that women with short interpregnancy intervals

have other risk factors for adverse outcomes (6). The cause of the association between long IPI and adverse perinatal outcomes has been hypothesized to be caused by a reversion of the mother's physiologic growth-supporting capacity to a primigravid state, which may explain why mothers with an IPI longer than 59 months have perinatal outcomes similar to those of primigravid women (8). Some, however, argue that adverse perinatal outcomes in women with long IPIs could be artifactual, with the adverse outcomes attributable to factors such as abortions in the interim or secondary infertility (6).

The relationship between IPI and maternal outcomes is less studied than the relationship between IPI and perinatal outcomes; many associations remain unclear. A systematic review of IPI and maternal outcomes showed that IPIs of 5 years or more appear to be independently associated with a 60 to 80% increased risk of preeclampsia (9). The review reported an increased risk of uterine rupture in women attempting vaginal birth after cesarean section as well as increased risk of uteroplacental bleeding disorders in women with short IPIs. The same review reported inconclusive evidence on the relationship between IPI and anemia or maternal death.

Factors associated with interpregnancy interval

This paper will examine the relationship between pregnancy intendedness and IPI. The relationship between pregnancy intendedness and IPI is not well understood. It is not clear whether pregnancy intendedness is associated with non-optimal IPI or if it is an artifact of other factors affecting IPI including age, marital status, race, parity, and socioeconomic status (10).

There has been limited investigation of the causes of non-optimal IPI, with a further focus on short IPI rather than long IPI, which has also been linked to poor perinatal outcomes (8). A 1998 study of women in Utah found that, among women 20 years of age or older, Medicaid recipients, racial/ethnic minorities, and married women are more likely to have an IPI of less than 12 months. The study also found an inverse relationship between short IPI and age (11).

Some suggest that short IPI is often the result of unintended pregnancy, but this has not been fully explored. A 1994 longitudinal study of short IPI in teenagers included a retrospective measure of pregnancy wantedness. This study found a statistically significant higher risk of a closely spaced second birth (within 24 months of the index birth) for teenage mothers who are black or Hispanic (compared to white), have lower parental education, have fewer years of education, did not complete at least one year of schooling during the birth interval, are married or became married during the interval, or wanted the first birth (12). Likewise, a 2001 study of determinants of short IPI in Denmark found that, along with maternal age 31-49, higher parity, menstrual irregularity, unemployment, and rural housing, unplanned pregnancy was associated with an increased risk of IPI of 9 months or less (OR 2.89, 95% CI (2.16, 3.87)) (13).

Pregnancy intendedness

Unintended pregnancy also represents an important public health and social issue in the United States. In 2006, the most recent year for which data is available, unintended pregnancies constitute 49% of all pregnancies in the United States, with a rate of 52 unintended pregnancies for every 1,000 women aged 15-44 years (14). The percent of unintended pregnancies in the United States is disproportionately higher among women aged 15-19 years, women with less than a college education, black women, and low-income women (14). In Georgia in 2006, unintended pregnancies constitute 57% of all pregnancies, with a rate of 60 unintended pregnancies for every 1,000 women aged 15-44 years (15). Unintended pregnancy is included in the United States Healthy People 2020 objectives, with a goal of increasing the proportion of pregnancies that are intended from 51% in 2002 to 56% in 2020 (2). Pregnancy intention in itself has been proposed as an exposure linked to adverse perinatal and maternal outcomes; however, research thus far has shown mixed results regarding whether pregnancy intendedness is independently associated with health outcomes.

Pregnancy intendedness and health outcomes

Studies on the association between pregnancy intention and perinatal outcomes have been limited. Furthermore, results have been mixed and inconclusive. A 2008 review of studies examining the association between pregnancy intention and birth outcomes concluded that rigorous United States studies suggest weak or no association between pregnancy intention and birth outcomes (16). A 2010 review of studies examining the association between pregnancy intention and pregnancy outcomes found that studies have been inconsistent, with some showing a negative impact of pregnancy unintendedness, while others show no effect (17). Of the studies that show a negative effect of pregnancy unintendedness on pregnancy outcomes, the negative effect was found to be greater among black and Hispanic mothers.

A 2011 meta-analysis of the association between pregnancy intendedness and perinatal outcomes found that pregnancy intention was significantly associated with several perinatal outcomes (18). The study found that unintended pregnancies were associated with low birthweight (unadjusted OR 1.36, 95% 1.25, 1.48) and preterm birth (unadjusted OR 1.31, 95% CI 1.09, 1.58); mistimed pregnancies were associated with low birthweight (unadjusted OR 1.31, 95% CI 1.13, 1.52); and unwanted pregnancies were associated with low birthweight (unadjusted OR 1.51, 95% CI 1.29, 1.78) and preterm birth (unadjusted OR 1.50, 95% CI 1.41, 1.61). One 2007 study on the association between pregnancy intention and perinatal outcomes found few significant associations. Of the significant associations, the OR for low birthweight was found to be 1.15 (95% CI 1.02-1.29) among ambivalent mothers and 0.92 (95% CI 0.86-0.97) for mistimed pregnancies (both compared to intended pregnancies) (19). The OR for preterm birth among unwanted compared to intended pregnancies was 1.16 (95% CI 1.01-1.33). The study concluded that it remained unclear whether pregnancy intention was independently associated with poor perinatal outcomes, or rather a risk marker for other factors which lead to those outcomes. A study examining the association between of pregnancy intention and preterm birth by race/ethnicity found different effects by racial/ethnic group (20).

The relationship between pregnancy intention and maternal outcomes is unclear, with little significant evidence. A 2010 review of studies examining the association between pregnancy intention and maternal outcomes found little supportive evidence (17). A 2007 study found no significant associations between pregnancy intention and any maternal outcomes overall when adjusting for an a priori confounder set. The same study, when examining the relationship between pregnancy intention and a number of individual maternal outcomes, found only one significant adjusted association, between unwanted pregnancy and premature rupture of membranes (19).

Little research has been conducted on the association between pregnancy intention and child development or parental health. One review article summarized findings from research from around the world on pregnancy intention and its association with child mortality, child development, and parental health (16). The review found evidence suggestive of a disadvantage in child mortality for unintended children as well as an association between unintended pregnancy and child abuse. The review also cited limited evidence that unintended pregnancy is associated with maternal depression.

Measurement of pregnancy intendedness

The majority of studies on pregnancy intention and health outcomes acknowledge the methodological limitation posed by the difficulty of measuring the concept of pregnancy intendedness. Studies have often also been limited by retrospective reporting of pregnancy intention. Pregnancy intention is now recognized to be a more complex and nuanced concept than simply planning a pregnancy.

A 1999 article highlighting inconsistencies in women's self-reported intendedness of pregnancy sparked interest in the meaning and measurement of pregnancy intention. In the article, the authors used data from the 1995 National Survey of Family Growth (NSFG) to show inconsistencies between traditional measures of pregnancy intention (based on timing of

pregnancy) and other measures of pregnancy intention such as contraceptive use and happiness upon learning of the pregnancy (21). The authors concluded that additional work was needed to understand and measure pregnancy intention.

Similarly, a 2010 review article concluded that, while contraceptive use is associated with pregnancy intention, the relationship was far from predictive (17). Indeed, the concept of pregnancy intention goes well beyond simple contraceptive use and planning of a pregnancy and into the realm of psychology and sociology. A review article showed that diverse factors including difficulties with contraceptive methods and side effects, unexpected intercourse, low risk perception, lack of access/knowledge to get contraceptives, cost of contraceptives, ambivalent attitudes about pregnancy, partner opposition, and influence of family and friends are all associated with contraceptive use (22). The sociological meaning of pregnancy intendedness, and specifically the measurement of the concept, continues to be the topic of research and debate (23, 24).

A variety of measures can be used to represent pregnancy intention. Common indicators include pregnancy intention/planning, pregnancy wantedness, happiness upon becoming pregnant, timing/mistiming of the pregnancy, and effort made to achieve or avoid pregnancy. Studies often use a dichotomized definition of pregnancy intention, whether it be wanted vs. unwanted, intended vs. unintended, or another grouping, for convenience and statistical power. It is increasingly recognized that important distinctions in subgroups of pregnancy intention categories are being overlooked by this dichotomization (17, 19, 25, 26).

A number of qualitative (27-29) and quantitative studies (19, 24, 26) have been conducted to refine the concept, measurement, and classification of pregnancy intention, including the idea of ambivalence, for public health research and practice.

A number of studies have examined inconsistencies in responses to surveys measuring pregnancy intention. The 1999 study mentioned above noted that contradictions in the NSFG show that contraceptive use at the time of conception is not necessarily an indicator that pregnancy wasn't intended or wanted. The authors suggest that this could be because of ambivalence, which may lead to imperfect contraceptive use (21). Another article noted that, according to the classification of intention by NSFG standards, pregnancies classified as wanted due to their timing may actually be considered unwanted by a young first-time mother, while a pregnancy classified as unwanted due to its timing may be welcomed as wanted by an older mother who already has children (23). A 2003 review article noted that reproductive intentions constituted only a good indicator of subsequent fertility rather than a perfect one, and that intention status correlates relatively well with happiness to be pregnant (24). The same review also noted the bias introduced by asking women to report pregnancy intendedness after the pregnancy, citing a study which showed that self-reported intendedness of pregnancies of changes over time in both directions, from unwanted to wanted and vice versa; the measure, however, remains consistent at the population level.

Other studies have compared survey responses to other qualitative or quantitative measures of intention. One study compared responses to the NSFG survey items measuring pregnancy intendedness with qualitative measures of pregnancy intention (29). The qualitative portion of the study found five dimensions of pregnancy intention: "(1) preconception desire for pregnancy, (2) steps taken to prepare for pregnancy, (30) fertility behavior and expectations, (4) postconception desire for pregnancy, and (5) adaptation to pregnancy and baby." When comparing the NSFG measures of pregnancy intention to the qualitative dimensions of intention, the study found ambivalence toward desire for the pregnancy in all of the NSFG categories of pregnancy intention (based on pregnancy timing/mistiming). Furthermore, the study found significant heterogeneity in all five qualitative dimensions of pregnancy intention among the NSFG

"mistimed" category of pregnancy intention. Another study used two different survey instruments, the NSFG and the Demographic and Health Survey, to test whether young women were misreporting mistimed pregnancies, specifically pregnancies which occurred earlier than desired although a child was desired at some time in the future, as unwanted on the NSFG. The study did not find evidence that this was the case (31).

Many studies have also examined subgroups of pregnancy intention to determine whether they differ significantly. One study found that women with unintended pregnancies (including those classified as unwanted, mistimed, and ambivalent using items from the Pregnancy Risk Assessment Monitoring System) differed significantly from women with intended pregnancies in almost all maternal characteristics and behaviors, including age, race/ethnicity, marital status, education, smoking and drinking during pregnancy, and stress (19). The authors further suggest that analyzing women who are ambivalent to their pregnancies separately may reveal a subgroup with unique characteristics and risk factors. A 2003 review article notes that the category of "unintended" pregnancy, which includes both unwanted and mistimed pregnancies, includes significant heterogeneity in life experiences, varying from a pregnancy which may have been mistimed by less than a year to a pregnancy which was mistimed by four years or more to a pregnancy which was considered entirely unwanted (24). Another article on the extent of pregnancy mistiming found that maternal characteristics differed between categories of pregnancy timing. Moderately mistimed pregnancies were found to have significantly different maternal characteristics such as income level, education, and race from severely mistimed and unwanted pregnancies, leading the authors to recommend that all mistimed and unwanted pregnancies not be grouped together as "unintended" for the purpose of analysis, nor that all mistimed pregnancies be grouped together (26). Rather, the author recommends conducting analysis using four categories of intendedness (intended, moderately mistimed, seriously mistimed, and unwanted) or dichotomizing by combining moderately mistimed and intended

pregnancies in one category and severely mistimed and unwanted pregnancies in another. Another study on pregnancy intention and maternal behaviors found significant associations between maternal behaviors including smoking during pregnancy, use of WIC services, and use of prenatal care and pregnancy intention status (wanted to be pregnant now, later, or never) (32). Another study concluded that mistimed and unwanted pregnancies differ significantly in most respects, including risk factors, and should therefore be analyzed separately (25).

This paper will contribute to the developing understanding of pregnancy intention and interpregnancy interval and their relationship to health outcomes.

CHAPTER II: MANUSCRIPT

Abstract

Background. Short or long interpregnancy interval (IPI) is associated with adverse perinatal outcomes. It is not clear whether pregnancy intendedness is associated with non-optimal IPI or if both unintended pregnancy and non-optimal IPI are caused by common sociodemographic factors.

Methods. Using cross-sectional data from the Georgia Pregnancy Risk Assessment Monitoring System (PRAMS) from 2004-2008 (n=3,133), multivariate logistic and polytomous regression models were used to calculate odds ratios (ORs) for non-optimal (<18 or >59 months), short (<18 months), and long (>59 months) IPI by pregnancy intention status (mistimed, unwanted, or ambivalent, compared to intended). ORs adjusting for maternal age, race/ethnicity, marital status, and education were calculated.

Results. 49.5% of births occurred after a non-optimal IPI. 31.6% and 17.9% of births occurred after short and long IPIs, respectively. A non-optimal IPI was more likely to occur after an unintended pregnancy (OR 1.80, 95% confidence interval (CI) 1.40, 2.31). A short IPI was more likely to occur after a mistimed (OR 2.89, 95% CI 1.95, 4.29), unwanted (OR 2.28, 95% CI 1.46, 3.55), or ambivalent pregnancy (OR 2.11, 95% CI 1.50, 2.96). Long IPI had a weak and non-significant association with unintended pregnancy (OR 1.14, 95% CI 0.80, 1.60).

Conclusion. The findings suggest that short IPI is associated with unintended pregnancy, even when controlling for sociodemographic factors. Long IPI appears to be associated with other factors beyond pregnancy intendedness. The findings have implications for future research on the health outcomes associated with short IPI as well as the causes of long IPI.

Background

Interpregnancy interval (IPI) has gained attention as an important public health issue associated with adverse health outcomes. Short interpregnancy interval is included in the United States Healthy People 2020 objectives, with a goal of reducing the proportion of pregnancies conceived within 18 months of a previous birth from 35.3% in 2006-2008 to 31.7% in 2020 (2).

For at least 50 years, an observed association between short IPIs and adverse perinatal outcomes has been recorded (5). While doubt remains about whether adverse perinatal outcomes are associated with inadequate IPI or whether the relationship is simply due to confounding or unmeasured factors (6), it is generally accepted that both short and long IPIs are linked to adverse perinatal outcomes including preterm birth, low birth weight, and small size for gestational age. Based on perinatal outcomes, it is generally agreed that an IPI of 18-23 months is ideal (7, 8), although most studies have shown weak or no associations between IPIs up to 18-59 months and adverse perinatal outcomes (3). The relationship between IPI and maternal outcomes is less studied than the relationship between IPI and perinatal outcomes; many associations, such as the relationship between IPI and maternal death, anemia, preeclampsia, labor dystocia, and uterine rupture remain unclear (9).

This paper will examine the relationship between pregnancy intendedness and IPI. It is not clear whether pregnancy intendedness is associated with non-optimal IPI or if it is an artifact of other factors affecting IPI including age, marital status, race, parity, and socioeconomic status (10). Some suggest that short IPI is often the result of unintended pregnancy, but this has not been fully explored. A 1994 longitudinal study of short IPI in teenagers included a retrospective measure of pregnancy wantedness. This study found a statistically significant higher risk of a closely spaced second birth (within 24 months of the index birth) for teenage mothers who wanted the first birth (12). A 2001 study of determinants of short IPI in Denmark found that, along with maternal age 31-49, higher parity, menstrual irregularity, unemployment, and rural

housing, unplanned pregnancy was associated with an increased risk of IPI of 9 months or less (OR 2.89, 95% CI (2.16, 3.87)) (13).

Unintended pregnancy also represents an important public health and social issue in the United States. In 2006, the most recent year for which national level data is available, unintended pregnancies constitute 49% of all pregnancies in the United States, with a rate of 52 unintended pregnancies for every 1,000 women aged 15-44 years (14). Unintended pregnancy is included in the United States Healthy People 2020 objectives, with a goal of increasing the proportion of pregnancies that are intended from 51% in 2002 to 56% in 2020 (2). Pregnancy intention in itself has been proposed as an exposure linked to adverse perinatal and maternal outcomes; however, research thus far has shown mixed results regarding whether pregnancy intendedness is independently associated with health outcomes.

Pregnancy intendedness is a complicated concept based in varying sociocultural norms whose definition has provoked much discourse. The majority of studies on pregnancy intention and health outcomes acknowledge the methodological limitation posed by the difficulty of measuring the concept of pregnancy intendedness.

It is unclear whether pregnancy intendedness is causally associated with short interpregnancy interval or if both short pregnancy interval and unintended pregnancy occur as a result of similar sociocultural influences. Likewise, questions remain about whether non-optimal pregnancy interval causes adverse pregnancy outcomes or whether the relationship is an artifact of other exposures related to interpregnancy interval. This paper will investigate whether pregnancy intendedness is associated with non-optimal interpregnancy interval, controlling for shared sociocultural and other factors. It will also investigate whether this association differs between groups. The findings of this research could impact public health programming in the prevention of adverse perinatal outcomes. The findings of this research will also contribute to a better understanding of the mechanisms through which non-optimal interpregnancy intervals occur.

Materials and Methods

Study population

This study uses data from the Georgia Pregnancy Risk Assessment Monitoring System (PRAMS) . PRAMS is an initiative of the Centers for Disease Control and Prevention to monitor maternal behaviors and experiences before and during pregnancy and during the infancy of a child (33). PRAMS is implemented by individual states. Women in a given state who have recently given birth to a live infant are sampled, with oversampling of populations of special public health interest such as racial/ethnic minorities and women who gave birth to a low birthweight infant. Women are contacted by mail and nonrespondents are followed up by telephone. The data used for this study consists of 10,747 women who had a live birth in Georgia between 2004 and 2008 and completed the PRAMS survey for that birth. The study was approved by the Emory University Institutional Review Board.

Outcome

The outcome of interest is interpregnancy interval, defined as the interval between the birth of the previous child and the conception of the subsequent child. Interbirth interval, the period between the birth of the previous child and the birth of the subsequent child, is recorded on the birth certificate. Gestational age of the subsequent child is also recorded on the birth certificate. Interpregnancy interval was calculated by subtracting the gestational age of the PRAMS birth from the interbirth interval. IPI was classified in two different ways. First, IPI was dichotomized into optimal (18-59 months) and non-optimal (less than 18 months or more than 59 months) categories. In order to explore the possible different origins of short and long IPI, IPI was also categorized into short (less than 18 months), moderate (18-59 months), and long (more than 59 months) categories.

Exposure

The exposure of interest, pregnancy intention, was classified according to the woman's responses to the following PRAMS questions: "Thinking back to just before you got pregnant with your

new baby, how did you feel about becoming pregnant?" (possible responses: wanted to be pregnant sooner, then, later, or not then nor at any time in the future) ; "When you got pregnant with your new baby, were you trying to get pregnant?"; and "When you got pregnant with your new baby, were you and your husband or partner doing anything to keep from getting pregnant?". Pregnancies classified as intended included those for which the woman wanted to be pregnant then or sooner and was trying to get pregnant as well as those for which the woman wanted to be pregnant then or sooner and was not trying to get pregnant but was also not doing anything to prevent pregnancy. Unintended pregnancies included all pregnancies not considered intended (19). Unintended pregnancies were also classified into three different categories: mistimed, unwanted, and ambivalent. Pregnancies classified as mistimed include those for which the woman wanted to be pregnant later, was not trying to get pregnant, and was doing something to prevent pregnancy. Pregnancies classified as unwanted include those for which the woman did not want to be pregnant then or in the future, was not trying to get pregnant, and was doing something to prevent pregnancy. The ambivalent category of pregnancy intendedness attempts to summarize all those pregnancies which occur in a state of discordance between expressed pregnancy desires and reproductive actions, a phenomenon documented by various studies (23, 24). Pregnancies classified as ambivalent include those for which the woman wanted to be pregnant later or never, but was trying to get pregnant; those for which the woman reported wanting to be pregnant then or sooner, but was not trying to get pregnant and was doing something to prevent pregnancy; and those for which the woman wanted to be pregnant later or never, but was not trying to get pregnant and was not doing anything to prevent pregnancy. These categorizations of pregnancy intention build upon the traditional categories of pregnancy intention defined in PRAMS through the use of the question, "Thinking back to just before you got pregnant with your new baby, how did you feel about becoming pregnant?" and the four possible responses of sooner, then, later, or not then nor in the future by adding information about reproductive actions in addition to feelings about pregnancy to construct a variable indicating

ambivalence, or contradictory attitudes, towards pregnancy. The traditional PRAMS intention classifications are compared to the classifications used in this study in Table 1.

Potential confounders

Covariates considered for inclusion in the model as potential confounders included maternal age, race/ethnicity, parity (number of live births including the present birth), marital status, father's information missing from the birth certificate, and mother's education. The variables for pregnancy intention came from PRAMS. The variables for interpregnancy interval, maternal age, race/ethnicity, parity, marital status, father's information missing from the birth certificate, and mother's education came from the birth certificates.

Potential confounders were grouped in the following manner, seeking to balance the loss of information due to categorization with the need for stability in the modeling process. Maternal age was classified as less than 20; 20-24; 25-29; 30-34; 35-39; or 40 or more years. Maternal race/ethnicity was classified as White non-Hispanic; Black non-Hispanic; Hispanic; and Other (including Asian, Hawaiian/Pacific Islander, American Indian/Alaska Native, and multiracial). Parity was grouped as 2 live births or 3 or more live births. Marital status remained as recorded on the birth certificate, as married vs. other. A binary indicator variable was created to adjust for whether or not the father's information (e.g. race/ethnicity, age, education) was missing from the birth certificate, as this has been found to be a risk factor for poor pregnancy outcomes (34). Mother's education was grouped into three categories: less than high school; complete high school or partial college; and complete college or more.

Analysis

Unadjusted odds ratios (ORs) and 95% confidence intervals were calculated to determine crude associations between the outcome (IPI) and potential confounders and the binary exposure (unintended pregnancy). Unadjusted ORs were also calculated between the exposure of interest

(pregnancy intendedness) as well as potential confounders and the binary outcome (non-optimal IPI).

ORs stratified separately by maternal age, race/ethnicity, parity, marital status, father's information missing from the birth certificate, and mother's education were examined for evidence of effect modification. Maternal age and education were chosen as potential effect modifiers to consider for inclusion in the model.

A traditional logistic regression model with the binary outcome of non-optimal IPI was fit, as well as a polytomous logistic model with a three-part outcome of short, moderate, and long IPI. Evidence of effect measure modification was first evaluated through inclusion of all candidate 2-way interactions in the fully adjusted models. After assessing for multicollinearity, interaction terms were then examined for statistical significance and relevance in the context of a general trend in the data. All interaction terms were eliminated due to lack of significance, with the exception of one significant interaction in one level of maternal age.

Confounding was assessed by conducting backward elimination from a fully adjusted model including all potential confounders. Criteria for inclusion as a confounder included a meaningful change (using a threshold of 10%) in the OR for unintended pregnancy upon removal of the potential confounder as well as the importance of the variable in the a priori theoretical relationship described for the model.

Adjusted ORs for non-optimal IPI were calculated using a logistic regression model including the aforementioned potential confounders. Adjusted ORs for short vs. moderate IPI and long vs. moderate IPI were calculated using a polytomous regression model also including the same potential confounders. Analyses were conducted using SUDAAN Statistical Software for the Analysis of Complex Survey, Clustered, or Other Correlated Data, release 10.0.1.

Results

Sample characteristics

Of the 10,747 observations in the PRAMS dataset from 2004 to 2008, 3,846 observations were removed due to missing pregnancy intention status and an additional 3,768 observations were removed due to missing values or not applicable values (in the case of first births) for interpregnancy interval, leaving a final sample size of 3,133 observations. The final analysis included 3,133 participants. Their characteristics are presented in tables 2a and 2b. Of the participants, 47.9%[*] were White non-Hispanic, while 30.4% were Black non-Hispanic, 16.4% were Hispanic, and 5.3% were other. Data was missing on race/ethnicity for 42 participants. In education, 22.5% of participants had less than a high school education, while 53.1% had complete high school or partial college, and 24.3% had complete college or more. 797 participants were missing data on education.

Characteristics associated with IPI

Table 2a shows the characteristics of the study participants by IPI. 31.6% of participants had a short IPI (less than 18 months), 50.5% had a moderate IPI (18-59 months), and 17.9% had a long IPI (more than 59 months). Unintended pregnancies overall had a significant positive unadjusted association with non-optimal IPI (OR 1.67, 95% CI 1.34, 2.09), as did the subcategories of mistimed pregnancies (OR 1.79, 95% CI 1.29, 2.49), unwanted pregnancies (OR 1.91, 95% CI 1.31, 2.77), and ambivalent pregnancies (OR 1.55, 95% CI 1.19, 2.02). Women less than 20 years or greater than 35 years of age, Black women, unmarried women, and women with 3 or more live births were more likely to have non-optimal IPIs. Women less than 24 years of age accounted for proportionally more of the short IPIs, while women over 30 years of age accounted for proportionally more of the long IPIs.

[*] Weighted percentages

Characteristics associated with pregnancy intendedness

Table 2b shows the characteristics of the study participants by pregnancy intendedness category. Short IPIs had a significant positive unadjusted association with unintended pregnancy (OR 2.06, 95% CI 1.59, 2.66), while long IPIs had a non-significant positive association (OR 1.18, 95% CI 0.89, 1.58). Women less than 24 years of age, Black, Hispanic, and unmarried women, those with less than a complete college education, and those with 3 or more live births were more likely to have unintended pregnancies. Women over 30 years of age were less like to have unintended pregnancies.

Multivariable analysis

For both the traditional logistic regression model and the polytomous logistic model, all interaction terms were eliminated due to lack of significance, with the exception of one significant interaction in one level of maternal age. While statistically significant in this large dataset, this term was removed due to little meaningful difference across strata (Figure 1), leaving no interaction terms in the model. Confounding was assessed by conducting backward elimination from a fully adjusted model including all potential confounders. Criteria for inclusion as a confounder included a meaningful change (using a threshold of 10%) in the OR for unintended pregnancy upon removal of the potential confounder as well as the importance of the variable in the a priori theoretical relationship described for the model. Following confounding assessment, maternal age, race/ethnicity, marital status, and education remained in the model as potential confounders.

Table 3 shows the results of the multivariate logistic and polytomous regression models using a binary exposure of unintended vs. intended pregnancy as well as mistimed, unwanted, and ambivalent pregnancies vs. intended pregnancy. All are adjusted for maternal age, race/ethnicity, marital status, and education.

The final adjusted logistic regression shows significantly increased odds of non-optimal IPI for unintended pregnancy overall (OR 1.80, 95% CI 1.40, 2.31), with higher odds for mistimed pregnancies compared to unwanted and ambivalent pregnancies. The polytomous regression shows significantly increased odds of short IPI compared to moderate IPI (OR 2.36, 95% CI 1.76, 3.18), again with higher odds for mistimed compared to unwanted and ambivalent pregnancies. The polytomous regression also shows small and non-significant increased odds of long IPI compared to moderate IPI for unintended pregnancy overall (OR 1.14, 95% CI 0.80, 1.60), with slightly increased odds for unwanted pregnancies compared to mistimed and ambivalent pregnancies.

Discussion

This study showed that, while sociodemographic factors such as maternal age, race/ethnicity, marital status, and education are important factors associated with non-optimal IPI, pregnancy intendedness also has a significant association with non-optimal IPI which is both statistically and clinically meaningful. Unintended pregnancies are more than 2 times as likely as intended pregnancies to have a non-optimal IPI. Furthermore, distinctions in the risk for non-optimal IPI can also be seen in the different subcategories of unintended pregnancy. Mistimed pregnancies are most likely to result in a non-optimal IPI (OR 2.89, 95% CI 1.95, 4.89), compared to ambivalent (OR 2.11, 95% CI 1.50, 2.96) and even unwanted pregnancies (OR 2.28, 95% CI 1.46, 3.55).

Also, this study shows that short IPI appears to have a different etiology and set of risk factors than long IPI. While unintended pregnancy was significantly and positively associated with short IPI, it had only a weak and non-significant positive association with long IPI, both in the aggregate and among the sub-categories of unintended pregnancy. The findings on long IPI could be due to several factors, including a causal relationship not captured by the model; bias; or uncertainty about unknown factors, such as fetal deaths or abortions.

This study was conducted using data with a large sample size over several years as well as oversampling to represent minority groups. The PRAMS data also met a response rate standard set by the Centers for Disease Control and Prevention. These features of the PRAMS data lend strength to the conclusions made in this study as well as their generalizability. This study also benefits from a novel classification of pregnancy intendedness which enhances the traditional PRAMS classification of pregnancy intention by including reproductive actions taken (in the form of contraceptive use) in addition to expressed reproductive desires. This classification adds to the body of literature documenting distinctions between categories of unintended pregnancy, and the importance of analyzing those categories separately due to differing maternal characteristics and risks (19, 24, 25).

The interpretation of the results of this study, however, is also subject to limitations. As the data is cross-sectional, it is not possible to comment on causation, but only on association. As described previously, pregnancy intention is a complicated concept which is not easily measured. Several studies have documented the insufficiency of existing survey instruments for measuring pregnancy intention (21, 24, 31). While this study improves upon the traditional PRAMS classification of pregnancy intendedness, it is still limited by the complex nature of pregnancy intention and the debatable ability to capture it through quantitative surveys. The measure of pregnancy intention is also potentially biased due to the fact that it is retrospectively reported after the birth of the child, which could affect the mother's perceptions of the intendedness of the pregnancy. This bias due to retrospective reporting has been documented, but it was also found to have a two-way effect which balanced out in analysis (35). Thus, while misclassification potentially exists, it is possible that the effect estimates have not been biased in either direction. The findings may also be limited by missing data. Of the original 10,747 observations in years 2004-2008, 3,846 observations were excluded due to missing data on pregnancy intention. Those with missing data for intention status were slightly more likely to be young; Black non-Hispanic

or Hispanic; unmarried; or to have less than a high school education (data not shown). As the data appear to have been excluded differentially based on these factors, the weighting of the sample could have been affected, making the findings less reliable.

An additional limitation to note is the high but not implausible number of long IPIs observed, accounting for 17.9% of the total study sample. This result was compared to other studies on IPI in the United States and internationally. In the United States, Adams et al reported in 1997 that 16.8% of white and 24.8% of black low-risk women at their second birth in Georgia had IPIs ≥48 months (36). Getahun et al reported that 24.7% of white women and 19.0% of African American women in Missouri without preterm premature rupture of membranes had IPIs ≥36 months (37). In Latin America and the Caribbean, Conde-Agudelo et al reported 19.54% of women with an IPI ≥60 months (38). The prevalence of IPIs ≥60 months found in this study is slightly higher than that found by Adams et al in 1997, which could be due to the fact that the 1997 study is restricted to low-risk second births. It is comparable to that found in the Conde-Agudelo study, but it may not be appropriate to compare Georgia data with that from Latin America and the Caribbean. Considering that Missouri data showed a similar prevalence of women with IPIs ≥36 months as this study showed for women with IPIs ≥60 months, it appears that there is an anomaly in the data. This could be because the interbirth interval variable was calculated in error, or because the interbirth interval variable did not take into account intervening fetal deaths which could explain a long interval between live births, but not between pregnancies. Because the prevalence of long IPI was not implausible and was similar to previous estimates from Georgia, however, it was determined that long IPIs would not be excluded from the analysis. Rather, results related to long IPI should be interpreted with caution, recognizing that it may not be generalizable to another context.

Few studies have been conducted on the association between pregnancy intendedness and interpregnancy interval. While this study contributes information to the discourse on the causes

of short IPI, further studies on the causes of short and long IPI are required to confirm or add to the findings of this and similar studies.

The differences in the association between unintended pregnancy and short IPI among subcategories of unintended pregnancy could have implications for public health programmers and clinicians. For example, the high likelihood of a short IPI with unintended pregnancy among the categories of mistimed and unwanted pregnancies indicates possible contraceptive failure. Should this be the case, this implies a need for improved education and contraceptive services for women in order to prevent short IPIs and their accompanying health risks.

The weak and non-significant association between unintended pregnancy and long IPI also has public health implications. Given that women over 35 years of age are more likely to have a non-optimal IPI and that these same women are disproportionately represented among women with long IPIs, it is possible that older women experience not only the increased risk which accompanies childbearing at a more advanced age, but also possible adverse effects of long IPIs. Also considering that unintended pregnancy appears to be only weakly associated with long IPI, further investigation needs to be undertaken to identify the determinants of long IPIs, especially among older women, in order to quantify the risk and take appropriate measures through education, programming, and services.

Unintended pregnancy does appear to be linked with short IPI, even when controlling for sociodemographic factors. This is an important finding which should be taken into consideration in future studies on the health impact of unintended pregnancy.

References

1. Centers for Disease Control and Prevention, *Contraceptive use among postpartum women - 12 states and New York City, 2004-2006.* MMWR. Morbidity and Mortality Weekly Report, 2009. **58**(30): p. 821-6.
2. US Department of Health and Human Services. *Healthy People Family Planning*. 2011 January 4, 2012 (cited 2012 January 13, 2012); Available from: http://www.healthypeople.gov/2020/topicsobjectives2020/objectiveslist.aspx?topicId=13 .
3. Conde-Agudelo, A., A. Rosas-Bermudez, and A.C. Kafury-Goeta, *Birth spacing and risk of adverse perinatal outcomes: a meta-analysis.* JAMA, 2006. **295**(15): p. 1809-23.
4. Miller, J.E., *Birth intervals and perinatal health: an investigation of three hypotheses.* Family Planning Perspectives, 1991. **23**(2): p. 62-70.
5. Hogue, C.J., et al., *Racial disparities in preterm birth rates and short inter-pregnancy interval. An overview. LID - 10.1111/j.1600-0412.2011.01081.x (doi).* Acta Obstet Gynecol Scand, 2011.
6. Klebanoff, M.A., *The interval between pregnancies and the outcome of subsequent births.* New England Journal of Medicine, 1999. **340**(8): p. 643-4.
7. Zhu, B.P., *Effect of interpregnancy interval on birth outcomes: findings from three recent US studies.* International Journal of Gynaecology and Obstetrics, 2005. **89 Suppl 1**: p. S25-33.
8. Zhu, B.P., et al., *Effect of the interval between pregnancies on perinatal outcomes.* New England Journal of Medicine, 1999. **340**(8): p. 589-94.
9. Conde-Agudelo, A., A. Rosas-Bermudez, and A.C. Kafury-Goeta, *Effects of birth spacing on maternal health: a systematic review.* American Journal of Obstetrics and Gynecology, 2007. **196**(4): p. 297-308.
10. Royce, R.A., *Birth spacing--the long and short of it.* JAMA, 2006. **295**(15): p. 1837-8.

11. Centers for Disease Control and Prevention, *Risk factors for short interpregnancy interval--Utah, June 1996-June 1997.* MMWR. Morbidity and Mortality Weekly Report, 1998. **47**(43): p. 930-4.

12. Kalmuss, D.S. and P.B. Namerow, *Subsequent childbearing among teenage mothers: the determinants of a closely spaced second birth.* Family Planning Perspectives, 1994. **26**(4): p. 149-53, 159.

13. Kaharuza, F.M., S. Sabroe, and O. Basso, *Choice and chance: determinants of short interpregnancy intervals in Denmark.* Acta Obstet Gynecol Scand, 2001. **80**(6): p. 532-8.

14. Finer, L.B. and M.R. Zolna, *Unintended pregnancy in the United States: incidence and disparities, 2006.* Contraception, 2011. **84**(5): p. 478-85.

15. Finer, L.B. and K. Kost, *Unintended pregnancy rates at the state level.* Perspect Sex Reprod Health, 2011. **43**(2): p. 78-87.

16. Gipson, J.D., M.A. Koenig, and M.J. Hindin, *The effects of unintended pregnancy on infant, child, and parental health: a review of the literature.* Studies in Family Planning, 2008. **39**(1): p. 18-38.

17. Tsui, A.O., R. McDonald-Mosley, and A.E. Burke, *Family planning and the burden of unintended pregnancies.* Epidemiologic Reviews, 2010. **32**(1): p. 152-74.

18. Shah, P.S., et al., *Intention to become pregnant and low birth weight and preterm birth: a systematic review.* Matern Child Health J, 2011. **15**(2): p. 205-16.

19. Mohllajee, A.P., et al., *Pregnancy intention and its relationship to birth and maternal outcomes.* Obstetrics and Gynecology, 2007. **109**(3): p. 678-86.

20. Afable-Munsuz, A. and P. Braveman, *Pregnancy intention and preterm birth: differential associations among a diverse population of women.* Perspect Sex Reprod Health, 2008. **40**(2): p. 66-73.

21. Trussell, J., B. Vaughan, and J. Stanford, *Are all contraceptive failures unintended pregnancies? Evidence from the 1995 National Survey of Family Growth.* Family Planning Perspectives, 1999. **31**(5): p. 246-7, 260.

22. Ayoola, A.B., M. Nettleman, and J. Brewer, *Reasons for unprotected intercourse in adult women.* J Womens Health (Larchmt), 2007. **16**(3): p. 302-10.

23. Sable, M.R., *Pregnancy intentions may not be a useful measure for research on maternal and child health outcomes.* Family Planning Perspectives, 1999. **31**(5): p. 249-50.

24. Santelli, J., et al., *The measurement and meaning of unintended pregnancy.* Perspect Sex Reprod Health, 2003. **35**(2): p. 94-101.

25. D'Angelo, D.V., et al., *Differences between mistimed and unwanted pregnancies among women who have live births.* Perspect Sex Reprod Health, 2004. **36**(5): p. 192-7.

26. Pulley, L., et al., *The extent of pregnancy mistiming and its association with maternal characteristics and behaviors and pregnancy outcomes.* Perspect Sex Reprod Health, 2002. **34**(4): p. 206-11.

27. Higgins, J.A., J.S. Hirsch, and J. Trussell, *Pleasure, prophylaxis and procreation: a qualitative analysis of intermittent contraceptive use and unintended pregnancy*. Perspect Sex Reprod Health, 2008. **40**(3): p. 130-7.

28. Kendall, C., et al., *Understanding pregnancy in a population of inner-city women in New Orleans--results of qualitative research.* Social Science and Medicine, 2005. **60**(2): p. 297-311.

29. Stanford, J.B., et al., *Defining dimensions of pregnancy intendedness.* Matern Child Health J, 2000. **4**(3): p. 183-9.

30. Erickson, T.B., et al., *Executive summary of the American College of Obstetricians and Gynecologists Presidential Task Force on Patient Safety in the Office Setting: reinvigorating safety in office-based gynecologic surgery.* Obstetrics and Gynecology, 2010. **115**(1): p. 147-51.

31. Kaufmann, R.B., L. Morris, and A.M. Spitz, *Comparison of two question sequences for assessing pregnancy intentions.* American Journal of Epidemiology, 1997. **145**(9): p. 810-6.

32. Humbert, L., et al., *The effect of pregnancy intention on important maternal behaviors and satisfaction with care in a socially and economically at-risk population.* Matern Child Health J, 2011. **15**(7): p. 1055-66.

33. Shulman, H.B., et al., *The Pregnancy Risk Assessment Monitoring System (PRAMS): current methods and evaluation of 2001 response rates.* Public Health Reports, 2006. **121**(1): p. 74-83.

34. Tan, H., et al., *Missing paternal demographics: A novel indicator for identifying high risk population of adverse pregnancy outcomes.* BMC Pregnancy Childbirth, 2004. **4**(1): p. 21.

35. Joyce, T., R. Kaestner, and S. Korenman, *On the validity of retrospective assessments of pregnancy intention.* Demography, 2002. **39**(1): p. 199-213.

36. Adams, M.M., et al., *The relationship of interpregnancy interval to infant birthweight and length of gestation among low-risk women, Georgia.* Paediatric and Perinatal Epidemiology, 1997. **11 Suppl 1**: p. 48-62.

37. Getahun, D., et al., *Recurrence of preterm premature rupture of membranes in relation to interval between pregnancies.* American Journal of Obstetrics and Gynecology, 2010. **202**(6): p. 570.e1-6.

38. Conde-Agudelo, A. and J.M. Belizan, *Maternal morbidity and mortality associated with interpregnancy interval: cross sectional study.* BMJ, 2000. **321**(7271): p. 1255-9.

39. Larder C, G.V., *Michigan Department of Community Health; Interpregnancy Intervals, MI PRAMS 2007.* MI PRAMS Delivery, July 2010. **9**(1).

40. Auger, N., et al., *The joint influence of marital status, interpregnancy interval, and neighborhood on small for gestational age birth: a retrospective cohort study.* BMC Pregnancy Childbirth, 2008. **8**: p. 7.

41. Villamor, E., P. Sparen, and S. Cnattingius, *Risk of oral clefts in relation to prepregnancy weight change and interpregnancy interval.* American Journal of Epidemiology, 2008. **167**(11): p. 1305-11.

42. Stephansson, O., P.W. Dickman, and S. Cnattingius, *The influence of interpregnancy interval on the subsequent risk of stillbirth and early neonatal death.* Obstetrics and Gynecology, 2003. **102**(1): p. 101-8.

Tables

Table 1. Comparison of traditional PRAMS categorization of pregnancy intendedness to categorization used in this study

	Categories in this study				
Traditional PRAMS categories	Intended	Mistimed	Unwanted	Ambivalent*	**Total**
Intended (wanted then or sooner)	1335	0	0	129	1464
Mistimed (wanted later)	0	481	0	550	1031
Unwanted (wanted neither then nor in the future)	0	0	358	280	638
Total	1335	481	358	959	3133

*Ambivalent pregnancy includes the following: wanted to be pregnant later or never, but trying to get pregnant; wanted to be pregnant then or sooner, but not trying to get pregnant and doing something to prevent pregnancy; and wanted to be pregnant later or never, but not trying to get pregnant and not doing anything to prevent pregnancy

Table 2a. Number and weighted percentages* of maternal characteristics and pregnancy intention status by interpregnancy interval (dichotomous and categorical) and odds ratios for non-optimal interpregnancy interval, Georgia PRAMS 2004-2008

	Dichotomous						Categorical							
	Total		Optimal (18-59 months)		Non-Optimal (<18 or >59 months)		Short (<18 months)		Moderate (18-59 months)		Long (>59 months)		Odds Ratio**	95% CI
	n=3,133	%	n=1,413	%	n=1,720	%	n=1,025	%	n=1,413	%	n=695	%		
Pregnancy intendedness														
Intended	1335	47.7	683	54.1	652	41.3	314	36.4	683	54.1	338	49.9	1.00	reference
Unintended	1798	52.3	730	46.0	1068	58.7	711	63.6	730	46.0	357	50.1	1.67	(1.34, 2.09)
Intended	1335	47.7	683	54.1	652	41.3	314	36.4	683	54.1	338	49.9	1.00	reference
Mistimed	481	15.0	193	12.7	288	17.4	209	20.6	193	12.7	79	11.7	1.79	(1.29, 2.49)
Unwanted	358	8.6	140	7.1	218	10.3	135	10.3	140	7.1	83	10.1	1.91	(1.31, 2.77)
Ambivalent	959	28.6	397	26.2	562	31.1	367	32.7	397	26.2	195	28.3	1.55	(1.19, 2.02)
Maternal characteristics														
Age at PRAMS birth														
<20	135	3.6	40	2.5	95	4.8	95	7.5	40	2.5	0	0.0	2.24	(1.15, 4.35)
20-24	796	24.8	377	25.4	419	24.1	382	34.4	377	25.4	37	5.9	1.11	(0.82, 1.51)
25-29	872	28.1	448	30.4	424	25.8	238	25.5	448	30.4	186	26.3	1.00	reference
30-34	786	25.7	335	26.2	451	25.1	212	21.8	335	26.2	239	31.1	1.13	(0.84, 1.51)
35-39	441	15.2	181	13.7	260	16.7	79	9.3	181	13.7	181	29.9	1.44	(1.02, 2.03)
≥40	103	2.6	32	1.7	71	3.5	19	1.5	32	1.7	52	7.0	2.35	(1.19. 4.62)

	Dichotomous						Categorical							
	Total		Optimal (18-59 months)		Non-Optimal (<18 or >59 months)		Short (<18 months)		Moderate (18-59 months)		Long (>59 months)		Odds Ratio**	95% CI
	n=3,133	%	n=1,413	%	n=1,720	%	n=1,025	%	n=1,413	%	n=695	%		
Race/ethnicity														
White non-Hispanic	1144	47.9	546	50.2	598	45.6	384	49.0	546	50.2	214	39.6	1.00	reference
Black non-Hispanic	1512	30.4	623	27.0	889	33.9	512	31.6	623	27.0	377	38.0	1.38	(1.09, 1.76)
Hispanic	305	16.4	162	17.8	143	15.0	73	14.1	162	17.8	70	16.5	0.93	(0.66, 1.30)
Other	130	5.3	60	5.1	70	5.5	42	5.2	60	5.1	28	6.0	1.20	(0.68, 2.14)
Missing	42	-	-	-	-	-	-	-	-	-	-	-	-	-
Marital status at PRAMS birth														
Married	1852	63.9	868	66.8	984	61.0	565	61.0	868	66.8	419	61.0	1.00	reference
Other	1281	36.1	545	33.2	736	39.0	460	39.0	545	33.2	276	39.0	1.29	(1.02, 1.62)
Maternal education														
less than high school	443	22.5	184	21.5	259	23.5	194	26.6	184	21.5	65	18.4	1.19	(0.85, 1.67)
complete high school or partial college	1378	53.1	613	53.1	765	53.1	429	50.3	613	53.1	336	57.8	1.09	(0.84, 1.41)
complete college or more	515	24.3	250	25.4	265	23.4	147	23.1	250	25.4	118	23.8	1.00	reference
missing	797	-	-	-	-	-	-	-	-	-	-	-	-	-
Paternal information missing from birth certificate														
Yes	510	11.3	219	10.0	291	12.5	184	12.1	219	10.0	107	13.3	1.28	(0.93, 1.77)
No	2623	88.7	1194	90.0	1429	87.5	841	87.9	1194	90.0	588	86.7	1.00	reference

	Dichotomous						Categorical							
	Total		Optimal (18-59 months)		Non-Optimal (<18 or >59 months)		Short (<18 months)		Moderate (18-59 months)		Long (>59 months)		Odds Ratio**	
	n=3,133	%	n=1,413	%	n=1,720	%	n=1,025	%	n=1,413	%	n=695	%		95% CI
Parity at PRAMS birth														
2 live births	1697	55.0	791	56.6	906	53.2	513	53.1	791	56.6	393	53.4	1.00	reference
≥3 live births	1436	45.1	622	43.4	814	46.8	512	46.9	622	43.4	302	46.6	1.15	(0.92, 1.43)

*Percentages may not sum to 100 due to rounding.
**Odds ratios are calculated using dichotomous IPI classification (optimal/non-optimal).

Table 2b. Number and weighted percentages* of maternal characteristics and interpregnancy intervals by pregnancy intention status (dichotomous and categorical) and odds ratio for unintended pregnancy, Georgia PRAMS 2004-2008

							Unintended							
	Total		Intended		Unintended		Unwanted		Mistimed		Ambivalent			
	n=3,133	%	n=1,335	%	n=1,798	%	n=358	%	n=481	%	n=959	%	Odds Ratio**	95% CI
Interpregnancy interval														
<18 months	1025	31.6	314	24.1	711	38.5	135	37.8	209	43.3	367	36.1	2.06	(1.59, 2.66)
18-59 months	1413	50.5	683	57.2	730	44.4	140	41.2	193	42.7	397	46.3	1.00	reference
≥59 months	695	17.9	338	18.7	357	17.2	83	21.0	79	14.0	195	17.7	1.18	(0.89, 1.58)
18-59 months (optimal)	1413	50.5	683	57.2	730	44.4	140	41.2	193	42.7	397	46.3	1.00	reference
less than 18 or more than 59 months (non-optimal	1720	49.5	652	42.8	1068	55.6	218	58.8	288	57.3	562	53.8	1.67	(1.34, 2.09)
Maternal characteristics														
Age at PRAMS birth														
<20	135	3.6	19	1.8	116	5.3	21	6.2	48	8.1	47	3.6	3.28	(1.43, 7.51)
20-24	796	24.8	212	16.2	584	32.6	97	25.8	178	36.0	309	32.9	2.21	(1.60, 3.05)
25-29	872	28.1	371	29.4	501	26.9	83	21.8	136	29.8	282	26.9	1.00	reference
30-34	786	25.7	424	31.3	362	20.6	83	21.3	88	17.5	191	21.9	0.72	(0.53, 0.97)
35-39	441	15.2	249	18.1	192	12.6	58	20.7	31	8.7	103	12.2	0.76	(0.54, 1.09)
≥40	103	2.6	60	3.3	43	2.0	16	4.2	0	0.0	27	2.4	0.66	(0.34, 1.27)

							Unintended							
	Total		Intended		Unintended		Unwanted		Mistimed		Ambivalent			
	n=3,133	%	n=1,335	%	n=1,798	%	n=358	%	n=481	%	n=959	%	Odds Ratio**	95% CI
Race/ethnicity														
White non-Hispanic	1144	47.9	663	59.7	481	36.9	88	34.9	150	44.1	243	33.9	1.00	reference
Black non-Hispanic	1512	30.4	440	18.9	1072	41.1	237	49.6	261	33.3	574	42.5	3.51	(2.72, 4.53)
Hispanic	305	16.4	150	15.6	155	17.2	20	11.2	49	20.6	86	17.2	1.78	(1.27, 2.50)
Other	130	5.3	66	5.8	64	4.8	10	4.3	12	2.0	42	6.4	1.35	(0.76, 2.42)
Missing	42	-	16	-	26	-	3	-	9	-	14	-	-	-
Marital status at PRAMS birth														
Married	1852	63.9	1048	79.9	804	49.4	157	53.5	230	54.8	417	45.2	1.00	reference
Other	1281	36.1	287	20.1	994	50.6	201	46.5	251	45.2	542	54.8	4.08	(3.16, 5.25)
Maternal education														
less than high school	443	22.5	141	16.6	302	28.0	59	26.8	78	25.9	165	29.7	3.84	(2.68, 5.49)
complete high school or partial college	1378	53.1	529	49.1	849	56.9	195	60.2	223	59.1	431	54.4	2.64	(2.01, 3.47)
complete college or more	515	24.3	329	34.3	186	15.1	35	12.9	52	15.0	99	15.9	1.00	reference
missing	797	-	336	-	461	-	69	-	128	-	264	-	-	-
Paternal information missing from birth certificate														
Yes	510	11.3	87	5.2	423	16.9	95	21.1	96	15.6	232	16.2	3.73	(2.53, 5.51)
No	2623	88.7	1248	94.9	1375	83.1	263	78.8	385	84.4	727	83.8	1.00	reference

							Unintended							
	Total		Intended		Unintended		Unwanted		Mistimed		Ambivalent			
	n=3,133	%	n=1,335	%	n=1,798	%	n=358	%	n=481	%	n=959	%	Odds Ratio**	95% CI
Parity at PRAMS birth														
2 live births	1697	55.0	795	60.1	902	50.3	125	30.5	294	58.5	483	51.9	1.00	reference
≥3 live births	1436	45.1	540	39.9	896	49.7	233	69.5	187	41.5	476	48.1	1.49	(1.20, 1.86)

*Percentages may not sum to 100 due to rounding.
**Odds ratios are calculated using dichotomous pregnancy intention classification (intended/unintended).

Table 3. Adjusted odds ratio (and 95% confidence interval) for interpregnancy interval according to pregnancy intention among Georgia women participating in PRAMS survey, 2004-2008 (n=3,133)*

	Intended pregnancy (reference group)	Unintended pregnancy (binary outcome)			Unintended pregnancy (polytomous outcome)								
					Mistimed			Unwanted			Ambivalent		
	n	n	AOR	95% CI	n	AOR	95% CI	n	AOR	95% CI	n	AOR	95% CI
Interpregnancy interval													
Optimal (18-59 months)	683	730	1.00	reference	193	1.00	reference	140	1.00	reference	397	1.00	reference
Non-Optimal (<18 or >59 months)	652	1068	1.80	1.40, 2.31	288	2.16	1.52, 3.09	218	1.79	1.22, 2.63	562	1.62	1.21, 2.17
Short (<18 months)	314	711	2.36	1.76, 3.18	209	2.89	1.95, 4.29	135	2.28	1.46, 3.55	367	2.11	1.50, 2.96
Moderate (18-59 months)	683	730	1.00	reference	193	1.00	reference	140	1.00	reference	397	1.00	reference
Long (>59 months)	338	357	1.14	0.80, 1.60	79	1.12	0.67, 1.87	83	1.28	0.74, 2.21	195	1.07	0.71, 1.61

**Adjusted for maternal age, race/ethnicity, marital status, and education*

Table 4. Moderate and long interpregnancy intervals among women ≥30, number and weighted percent, combined and stratified by black non-Hispanic and white non-Hispanic race

All women ≥30

	Total		Moderate (18-59 months)		Long (>59 months)	
	n	%	n	%	n	%
Race/ethnicity						
White non-Hispanic	247	58.5	103	61.4	94	52.1
Black non-Hispanic	207	23.5	73	20.1	107	29.4
Hispanic	43	9.5	17	9.0	19	8.0
Other	40	8.5	18	9.5	12	10.6
Marital status at PRAMS birth						
Married	437	84.0	178	88.5	174	77.2
Other	107	16.0	35	11.5	59	22.8
Maternal education						
less than high school	37	9.9	15	12.6	14	6.5
high school	86	18.4	26	15.8	50	23.1
some college	94	23.0	31	18.4	51	30.7
complete college or more	165	48.7	75	53.2	53	39.7
Parity at PRAMS birth						
2 live births	228	42.9	93	43.3	101	45.1
3 live births	164	30.6	53	28.8	85	39.0
4 or more live births	152	26.5	67	27.9	47	15.9

Black non-Hispanic women ≥30

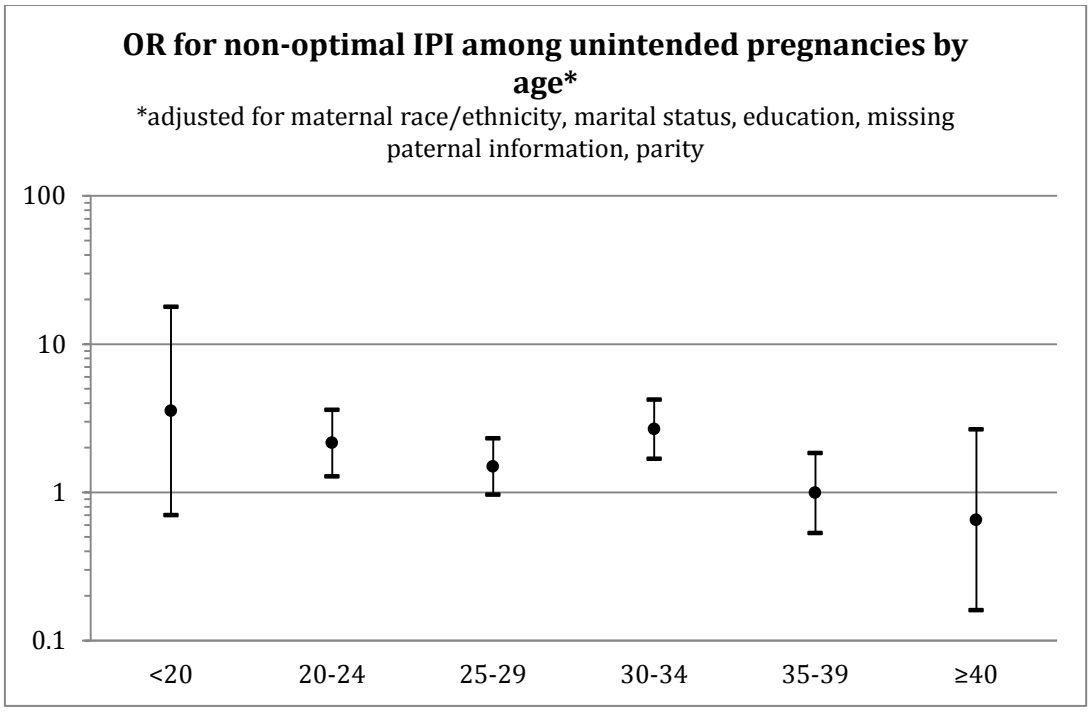
	Total		Moderate (18-59 months)		Long (>59 months)	
	n	%	n	%	n	%
Marital status at PRAMS birth						
Married	137	64.4	52	75.1	65	56.4
Other	70	35.6	21	24.9	42	43.6
Maternal education						
less than high school	13	6.9	3	4.9	8	7.1
high school	46	28.4	14	24.5	29	35.3
some college	43	26.9	13	24.6	25	28.5
complete college or more	53	37.9	22	45.9	20	29.1
Parity at PRAMS birth						
2 live births	83	35.2	25	18.2	50	53.7
3 live births	56	28.6	14	25.6	36	31.8
4 or more live births	68	36.2	34	56.2	21	14.5

White non-Hispanic women ≥30

	Total		Moderate (18-59 months)		Long (>59 months)	
	n	%	n	%	n	%
Marital status at PRAMS birth						
Married	229	96.8	98	99.6	84	94.5
Other	18	3.2	5	0.4	10	5.5
Maternal education						
less than high school	6	0.6	1	0.3	2	0.5
high school	34	18.5	11	17.5	16	19.5
some college	41	22.8	16	19.7	22	32.1
complete college or more	94	58.1	44	62.5	28	48.0
Parity at PRAMS birth						
2 live births	111	46.0	50	48.1	42	41.6
3 live births	83	34.0	32	34.3	39	45.2
4 or more live births	53	20.0	21	17.6	13	13.2

Figures

Figure 1. Odds ratio for non-optimal interpregnancy interval among unintended pregnancies by maternal age*



CHAPTER III: SUMMARY, PUBLIC HEALTH IMPLICATIONS, POSSIBLE FUTURE DIRECTIONS

Summary

This study showed that, while sociodemographic factors such as maternal age, race/ethnicity, marital status, and education are important factors associated with non-optimal IPI, pregnancy intendedness also has a significant association with non-optimal IPI which is both statistically and clinically meaningful. Unintended pregnancies are more than 2 times as likely as intended pregnancies to have a non-optimal IPI. Furthermore, distinctions in the risk for non-optimal IPI can also be seen in the different subcategories of unintended pregnancy. Mistimed pregnancies are most likely to result in a non-optimal IPI (OR 2.89, 95% CI 1.95, 4.89), compared to ambivalent (OR 2.11, 95% CI 1.50, 2.96) and even unwanted pregnancies (OR 2.28, 95% CI 1.46, 3.55).

Also, this study shows that short IPI appears to have a different etiology and set of risk factors than long IPI. While unintended pregnancy was significantly and positively associated with short IPI, it had only a weak and non-significant positive association with long IPI, both in the aggregate and among the sub-categories of unintended pregnancy. The findings on long IPI could be due to several factors, including a causal relationship not captured by the model; bias; or uncertainty about unknown factors, such as fetal deaths or abortions.

The finding of a weak, non-significant association between unintended pregnancy and long IPI has several possible explanations. First, the true causal factors for long IPI may not be captured in the model through pregnancy intendedness and the selected sociodemographic covariates. In such case, further research is called for to investigate the causes of long IPI, which are distinct from those associated with short IPI. Second, bias could be present in the model, obscuring the true relationship between unintended pregnancy and long IPI. Finally, uncertainty about factors

not known from the available data which may have additional explanatory power, such as fetal deaths since the last live birth or abortions, could also lead to incorrect conclusions about the relationship between pregnancy intendedness and long IPI. Overall, long IPI appears to be a phenomenon with a more complex nature than may be captured by the model. For instance, the majority of long IPIs occur among women 30 and older. When examining the socioeconomic and demographic factors associated with long IPIs in these women stratifying by race, however, long IPI appears to have very disparate origins (Table 4). Among black non-Hispanic women 30 and older, long IPIs occur disproportionately among unmarried women and those with a high school education or less. Among white non-Hispanic women, long IPIs occur disproportionately among married women and those with complete college education or more. The causes of long IPI among different racial/ethnic groups merits further investigation.

This study was conducted using data with a large sample size over several years as well as oversampling to represent minority groups. The PRAMS data also met a response rate standard set by the Centers for Disease Control and Prevention. These features of the PRAMS data lend strength to the conclusions made in this study. This study also benefits from a novel classification of pregnancy intendedness which enhances the traditional PRAMS classification of pregnancy intention by including reproductive actions taken (in the form of contraceptive use) in addition to expressed reproductive desires. This classification adds to the body of literature documenting distinctions between categories of unintended pregnancy, and the importance of analyzing those categories separately due to differing maternal characteristics and risks (19, 24, 25).

The interpretation of the results of this study is also subject to limitations. As the data is cross-sectional, it is not possible to comment on causation, but only on association. As described previously, pregnancy intention is a complicated concept which is not easily measured. Several studies have documented the insufficiency of existing survey instruments for measuring pregnancy intention (21, 24, 31). While this study improves upon the traditional PRAMS

classification of pregnancy intendedness, it is still limited by the complex nature of pregnancy intention and the debatable ability to capture it through quantitative surveys. The measure of pregnancy intention is also potentially biased due to the fact that it is retrospectively reported after the birth of the child, which could affect the mother's perceptions of the intendedness of the pregnancy. This bias due to retrospective reporting has been documented, but it was also found to have a two-way effect which would balance out in analysis (35). Thus, while misclassification potentially exists, it is possible that the effect estimates have not been biased in any direction.

Another potential source of bias exists due to potential misclassification within the categories of unintended pregnancy. In the categories of mistimed and unwanted pregnancy, while the woman reported whether she or her husband or partner were "doing anything to keep from getting pregnant," the survey does not further specify what contraceptive method was being used, if the woman answered in the affirmative. Due to this, the distinctions between the use of highly effective contraceptive methods such as the IUD or birth control pill compared to less effective contraceptive methods such as withdrawal, and whether the method was being used consistently, are not known. Depending on the contraceptive method and manner of use, some women could actually have been better categorized in the ambivalent category. It is possible that some women in the mistimed and unwanted categories could have been more accurately classified as ambivalent due to the use of less effective contraceptive methods or the inconsistent use of contraceptive methods. Considering that women using low-efficacy methods or using methods inconsistently would most likely have higher odds of experiencing a short IPI, this could have resulted in a bias away from the null in the ORs for the mistimed and unwanted and a bias towards the null for the ambivalent category.

The findings may also be limited by missing data. Of the original 10,747 observations in years 2004-2008, 3,846 observations were excluded due to missing data on pregnancy intention. Those with missing data for intention status were slightly more likely to be young (43.7% of total

sample <25 years vs. 49.5% of those missing intention data); Black non-Hispanic or Hispanic (50.6% of total sample vs. 55.7% of those missing intention data and 10.6% of total sample vs. 14.0% of those missing intention data, respectively); unmarried (51.6% of total sample vs. 60.5% of those missing intention data); or to have less than a high school education (18.6% of total sample vs. 25.2% of those missing intention data) (data not shown). As the data appear to have been excluded differentially based on these factors, the weighting of the sample could have been affected, making the findings less reliable.

An additional limitation to note is the high but not implausible number of long IPIs observed, accounting for 17.9% of the total study sample. This result was compared to other studies on IPI in the United States and internationally. In the United States, Adams et al reported in 1997 that 16.8% of white and 24.8% of black low-risk women at their second birth in Georgia had IPIs ≥48 months (36). Getahun et al reported that 24.7% of white women and 19.0% of African American women in Missouri without preterm premature rupture of membranes had IPIs ≥36 months (37). Michigan PRAMS data in 2007 reported 45.9% of women had IPIs ≥24 months (39). In Canada, Auger et al reported 19% of women with an IPI ≥36 months (40). In Sweden, Villamor et al reported 10.74% of women with an IPI ≥48 months at the second birth (41); Stephansson et al reported 16.14% of women with an IPI 36-71 months at the second birth, and 3.24% of women with an IPI ≥72 months at the second birth (42). In Latin America and the Caribbean, Conde-Agudelo et al reported 19.54% of women with an IPI ≥60 months (38). The prevalence of IPIs ≥60 months found in this study is slightly higher than that found by Adams et al in 1997, which could be due to the fact that the 1997 study is restricted to low-risk second births. It is comparable to that found in the Conde-Agudelo study, but it may not be appropriate to compare Georgia data with that from Latin America and the Caribbean. Considering that Missouri data showed a similar prevalence of women with IPIs ≥36 months as this study showed for women with IPIs ≥60 months, it appears that there could be an anomaly in the data. This could be

because the interbirth interval variable was calculated in error, or possibly because the interbirth interval variable did not take into account intervening fetal deaths which could explain a long interval between live births, but not between pregnancies. Because the prevalence of long IPI was not implausible and was similar to previous estimates from Georgia, however, it was determined that long IPIs would not be excluded from the analysis. Rather, results related to long IPI should be interpreted with caution, recognizing that it may not be generalizable to another context.

Given the findings of this study and taking into account the limitations described above, it appears that unintended pregnancy is linked with short IPI, even when controlling for sociodemographic factors. This lends support to the previously postulated idea that short IPIs are caused by unintended pregnancy, which until this point had only been investigated by few studies. This result is in agreement with the findings of those previous studies. One should be cautious, however, in interpreting this to mean the short IPIs are caused only by unintended pregnancy. The adjusted ORs reported in this study are not of such a magnitude to suggest such an association, and other contributing factors such as desired family size, prior parity, and prior fetal deaths should be investigated as other contributing factors.

Because of the oversampling of minority groups and the relatively high response rate achieved for the Georgia PRAMS data during the period of this study, the findings of this study related to short IPI and pregnancy intendedness have the potential to be generalized to other states of the United States. Given the unusual prevalence of long IPIs in the study sample, however, the results of this study related to long IPI may not be generalizable.

Public health implications

Unintended pregnancy does appear to be linked with short IPI, even when controlling for sociodemographic factors. This is an important finding which should be taken into consideration in future studies on the health impact of unintended pregnancy.

The differences in the association between unintended pregnancy and short IPI among subcategories of unintended pregnancy could have implications for public health programmers and clinicians. For example, the high likelihood of a short IPI with unintended pregnancy among the categories of mistimed and unwanted pregnancies indicates possible contraceptive failure. Should this be the case, this implies a need for improved education and contraceptive services for women in order to prevent short IPIs and their accompanying health risks for the infant as well as possibly for the mother.

The weak and non-significant association between unintended pregnancy and long IPI also has public health implications for programmers and clinicians. Given that women over 35 years of age are more likely to have a non-optimal IPI and that these same women are disproportionately represented among women with long IPIs, it is possible that older women experience not only the increased risk which accompanies childbearing at a more advanced age, but also possible adverse effects of long IPIs. Also considering that unintended pregnancy appears to be only weakly associated with long IPI, further investigation needs to be undertaken to identify the determinants of long IPIs, especially among older women, in order to quantify the risk and take appropriate measures through education, programming, and services.

Possible future directions

Few studies have been conducted on the association between pregnancy intendedness and interpregnancy interval. While this study contributes information to the discourse on the causes of short IPI, further studies on the causes of short IPI are required to confirm or add to the findings of this and similar studies.

Additional studies on long IPIs are needed, not only to determine the health outcomes associated with a long IPI, but also to examine the causes of long IPI. This study showed only a weak and non-significant positive effect of unintended pregnancy on long IPI, so in the future, additional exposures beyond pregnancy intention should be explored. It appears that the causes of short and

long IPI could be quite different, so the two outcomes should be considered separately in future investigations.

As mentioned above, this study was limited by the methodological difficulty of measuring the concept of pregnancy intention. Future studies using new and different methods of measuring pregnancy intendedness can be used to enhance our understanding of pregnancy intention and its relationship with health outcomes, and to confirm or refute the findings of this study.