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Birth Spacing and Parents' Physical and Mental Health: An Analysis Using Individual and Sibling Fixed Effects

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ABSTRACT An extensive literature has examined the relationship between birth spacing and subsequent health outcomes for parents, particularly for mothers. However, this research has drawn almost exclusively on observational research designs, and almost all studies have been limited to adjusting for observable factors that could confound the relationship between birth spacing and health outcomes. In this study, we use Norwegian register data to examine the relationship between birth spacing and the number of general practitioner consultations for mothers' and fathers' physical and mental health concerns immediately after childbirth (1–5 and 6–11 months after childbirth), in the medium term (5–6 years after childbearing), and in the long term (10–11 years after childbearing). To examine short-term health outcomes, we estimate individual fixed-effects models: we hold constant factors that could influence parents' birth spacing behavior and their health, comparing health outcomes after different births to the same parent. We apply sibling fixed effects in our analysis of medium- and long-term outcomes, holding constant mothers' and fathers' family backgrounds. The results from our analyses that do not apply individual or sibling fixed effects are consistent with much of the previous literature: shorter and longer birth intervals are associated with worse health outcomes than birth intervals of approximately 2–3 years. Estimates from individual fixed-effects models suggest that particularly short intervals have a modest negative effect on maternal mental health in the short term, with more ambiguous evidence that particularly short or long intervals might modestly influence short-, medium-, and long-term physical health outcomes. Overall, these results are consistent with small to negligible effects of birth spacing behavior on (non-pregnancy-related) parental health outcomes.

KEYWORDS Birth intervals • Physical health • Mental health • Parents • Fixed effects

Introduction

Physicians, epidemiologists, and social scientists have long been interested in the consequences of fertility behavior on parents' health. Thus, researchers have investigated how parental age at first birth, fertility quantum, and related factors affect mothers' and fathers' subsequent health and mortality risks (Barclay et al. 2016; Hanson et al. 2015). Another fertility dimension that has attracted much research

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interest is the extent to which the spacing between births influences the health of mothers and even fathers. Indeed, concerns about the potentially adverse effects of short birth intervals on mothers' and children's health have been a strong motive for family planning programs in lower income countries (Miller and Babiarz 2016; Yeakey et al. 2009). However, less is known about how short intervals might affect mothers' health in high-income countries, where family sizes are smaller and parents have better access to health care and nutrition, potentially yielding weaker effects than in lower income settings. Furthermore, most work in this field has used observational data (Conde-Agudelo et al. 2007), limiting the extent to which these studies could reduce confounding and identify the net effect of spacing between births on parents' health. Developing a greater understanding of the impact of birth spacing on parental health is important for parents and children and for the allocation of public health investments and related resources (Ahrens et al. 2019). The decreases in birth spacing between first and second births in many Western countries since the 1970s, in parallel with fertility postponement and declining fertility quantum (Miranda 2020), make such knowledge particularly relevant.

Given the vast literature examining the relationship between birth spacing behavior and pregnancy-related outcomes, we examine a more general measure of health in this study: primary care visits to a general practitioner (GP), based on Norwegian register data. We examine the link between birth interval length and GP visits for mothers' and fathers' mental and physical health issues in the short, medium, and long term. However, we exclude GP visits in which the diagnosis coding explicitly links the consultation to pregnancy complications. We begin our follow-up one month following the birth, thus not covering direct pregnancy or perinatal complications, although follow-up complications will often be captured in our data. Our health outcome does not include hospital care; however, the first step for receiving advanced health care treatment in nonemergency cases is interacting with the primary health care system.

Birth interval length could influence parents', particularly mothers', health outcomes for several reasons, even beyond pregnancy complications. First, numerous studies have reported a strong association between interval length and mothers' negative pregnancy outcomes (i.e., health-related). The worst outcomes tend to be concentrated among women who had short or long birth intervals, such as <12 or >60 months, respectively (Conde-Agudelo et al. 2007). The negative sequelae of these poor pregnancy outcomes might have implications for other aspects of the mother's health shortly after birth and for many years afterward. In addition, empirical research has found that birth intervals affect perinatal outcomes and infant mortality (Conde-Agudelo et al. 2006; Molitoris et al. 2019; Rutstein 2005). Thus, the World Health Organization recommends that women space their pregnancies by at least 24 months (World Health Organization 2007)—advice primarily directed toward mothers in low- and middle-income countries. Similarly, medical associations, such as the American College of Obstetricians and Gynecologists (ACOG), advise mothers to space their pregnancies by at least 6 months (ACOG 2019). Further evidence suggests that the pressures of raising closely spaced children can increase parental anxiety and stress, potentially leading to adverse health outcomes for mothers and fathers in the short, medium, and long term.

Nevertheless, the reported associations between birth interval length and parental outcomes might overstate the adverse effects of particularly short and long intervals. Data suggest that births after such intervals are concentrated among women with lower levels of education, those from disadvantaged minority groups, and teenage mothers. Furthermore, births after short intervals are more likely to be unplanned (Gemmill and Lindberg 2013; Liu et al. 2021). Research in Sweden suggests that the negative effects of short birth spacing on *children* are almost entirely explained by parental background factors (Barclay and Kolk 2017, 2018).

We add to the literature on this topic in several ways. First, we use within-individual fixed effects, comparing mothers' and fathers' postbirth outcomes after different births, following intervals of varying lengths to examine short-term (1–5 or 6–11 months postbirth), medium-term (60–83 months postbirth), and long-term (120–143 months postbirth) outcomes. Second, we conduct sibling comparison analyses (i.e., comparing a mother to her sisters, and a father to his brothers) to estimate the effect of birth spacing on parental health in the medium and long term, net of unobserved factors that are constant within the parent's sibling group. Such within-individual and sibling-group analyses are uncommon in the literature on this topic. By studying both mothers and fathers, holding unobserved factors at the individual and sibling-group levels constant, and studying short-, medium-, and long-term outcomes, we hope to gain insight into the relative importance of the physiological and social mechanisms that might link birth spacing to parental health outcomes.

Previous Empirical Research

In this section, we review research examining the relationship between birth spacing and various health outcomes for mothers and fathers. Specifically, we review research on a wide range of short-, medium-, and long-term health outcomes that could plausibly be linked with visits to a GP, the health outcome we measure in this study. Despite excluding GP visits related to pregnancy complications from our outcome variable, we review the literature on adverse pregnancy outcomes because they could have negative long-term effects that increase the likelihood of a GP visit.

Adverse Pregnancy Outcomes

Studies focusing on the potentially detrimental effects of short or long birth intervals in high-income countries have primarily focused on potential detrimental effects on children (Barclay and Kolk 2017, 2018; Buckles and Munnich 2012; Conde-Agudelo et al. 2006; Molitoris et al. 2019). Considerably less research has studied parental health. Most research on the relationship between birth spacing and parental health has used observational data, limiting the extent to which the net effect of birth spacing could be distinguished from confounding factors that jointly influence both birth spacing behavior and the health outcome under investigation. A systematic review of 22 studies published between 1966 and 2006 indicated that short birth intervals are associated with an increased risk of uterine rupture among women attempting a vaginal birth after previous cesarean delivery and an increased risk of uteroplacental bleeding disorders; long birth intervals were associated with an increased risk of preeclampsia and abnormally slow or protracted labor (Conde-Agudelo et al. 2007). A lack of clear and sufficient evidence has limited the extent to which conclusions can be drawn about the relationship between birth intervals and other outcomes, such as the risk of maternal death and anemia (Conde-Agudelo et al. 2007; Wendt et al. 2012). A more recent review covered six newer studies published between 2006 and 2018. This review reported that short interpregnancy intervals were associated with increased risks of obesity, gestational diabetes, precipitous labor, placental abruption, and labor dystocia and a decreased risk of preeclampsia (Ahrens et al. 2019; Appareddy et al. 2017; Blumenfeld et al. 2014; Davis et al. 2014; Hanley et al. 2017; Sandström et al. 2012; Zhu et al. 2006).

Although many of these studies have attempted to adjust for confounding in the relationship between birth spacing and maternal health outcomes, we know of only two studies that have specifically tried to adjust for both observed and unobserved characteristics that might drive an association between birth spacing and parental health. Hanley et al. (2017) and Liu et al. (2021) attempted to address unobserved confounding by comparing within-mother pregnancy outcomes after birth intervals of different lengths. Using perinatal register data from British Columbia, Canada, Hanley et al. examined gestational diabetes, preeclampsia, and obesity at the beginning of the following pregnancy. Short interpregnancy intervals (0–5 or 6–11 months) were associated with increased risks of gestational diabetes and obesity, and these risks persisted even in a within-mother comparison analysis (Hanley et al. 2017). They suggested that short intervals might mean that the mother has less time to lose weight before the following pregnancy, potentially increasing the risk of obesity at the beginning of that pregnancy; gestational diabetes is also associated with obesity (Hanley et al. 2017). Liu et al. (2021) used data from 1997–2012 California perinatal registers and a within-mother comparison design to examine severe maternal morbidity (SMM), defined to include potentially life-threatening conditions (e.g., eclampsia or sepsis). They found that relative to interpregnancy intervals of 18–23 months, shorter intervals (including 0–6 months) were associated with a lower risk of SMM, whereas longer intervals (including >59 months and 24–59 months) were associated with an increased risk of SMM (Liu et al. 2021).

Mental Health Outcomes

Relatively little research has examined the relationship between birth spacing and parental mental health using large-scale quantitative data. Research suggests that raising infant twins or infants separated by a short birth interval is more stressful for parents (Glazebrook et al. 2004) and that shorter birth intervals might increase the risk of parental divorce (Berg et al. 2020). Furthermore, research has suggested that parents of closely spaced children are more likely to report symptoms of depression than parents of more widely spaced children (Thorpe et al. 1991). With caution, we might also be able to draw inferences from research examining whether parents of twins—in some respects, a special case of extremely short birth spacing—have different mental health outcomes than parents of singletons. Research suggests that parents of twins are even more likely to report symptoms of anxiety and postpartum and early parenthood depression than parents of closely spaced children (Choi et al. 2009; Thorpe et al. 1991; Wenze et al. 2015). As mentioned earlier, some research also found that particularly short or long interpregnancy intervals can increase the probability of preterm birth and low birth weight (Conde-Agudelo et al. 2006), and the challenges of raising a child born preterm or with low birth weight might also increase the probability of suffering from depression (Poehlmann et al. 2009). However, the latter association is complicated by evidence suggesting that antenatal depression and anxiety might increase the probability of preterm delivery (Männistö et al. 2016; Staneva et al. 2015).

Long-Term Outcomes

Less research has examined longer term outcomes in relation to birth spacing, although several of these studies distinguish themselves by examining fathers in addition to mothers. Grundy and Kravdal (2014) used Norwegian register data to examine birth spacing history in relation to mothers' and fathers' mortality in late adulthood. They found that parents of two or three children had higher mortality if the intervening interval was 18 months or shorter relative to 30–41 months and that mortality was lower for parents of three or four children who experienced longer average birth intervals (Grundy and Kravdal 2014). They also found that short birth intervals between the first and second births were associated with increased medication use. Other research found that short birth intervals can increase mothers' mortality in later life (Grundy and Tomassini 2005) and increase mothers' and fathers' likelihood of long-term health impairments (Read et al. 2011). Hanson et al. (2015) used data from the Utah Population Database to examine the association between various dimensions of reproductive history, including birth spacing, and long-term morbidity. They found that having at least one long birth interval was associated with a lower likelihood of morbidity for women, but they found no association for men (Hanson et al. 2015). Other work also found that both particularly short or long birth intervals are associated with increased risk of cardiovascular disease (Ngo et al. 2016), cardiovascular-related mortality, and all-cause mortality (Weisband et al. 2020).

Theoretical Mechanisms

Health Consequences of Pregnancy and Childbirth

A review of the literature on potential mechanisms suggests that a few nonexclusive physiological processes might connect birth interval length with maternal health outcomes, including maternal nutrient depletion, incomplete healing of the uterine scar, an abnormal process of remodeling of endometrial blood vessels, and physiological regression (Conde-Agudelo et al. 2012). Although we do not study pregnancy-related outcomes, we review these mechanisms because some of these physiological processes and related outcomes might have negative consequences that extend beyond pregnancy and the immediate postnatal period. Excessively short birth intervals might cause maternal nutrient depletion, which could lead to negative maternal anthropometric effects, such as loss of fat stores, deficiencies of key nutrients, and a decrease in body mass index (Khan et al. 1998; Winkvist et al. 1992). However, this evidence is not overwhelmingly clear (Conde-Agudelo et al. 2012). In populations where malnutrition is a public health problem, admittedly uncommon in the Norwegian context that we study, maternal nutrient depletion might lead to an imbalanced nutrient distribution between the mother and the fetus (King 2003). Incomplete healing of a uterine scar might lead to uterine rupture if a cesarean delivery is followed by a short interpregnancy interval or by an attempt at vaginal delivery (Bujold and Gauthier 2010; Conde-Agudelo et al. 2007). Abnormal remodeling of endometrial blood vessels can lead to uteroplacental bleeding disorders, and the risk of this outcome increases with short interpregnancy intervals (Conde-Agudelo et al. 2006). Physiological regression is the only hypothesis that suggests a link between long birth intervals and maternal health outcomes. This hypothesis suggests that women experience numerous physiological adaptations that optimize the body for pregnancy and child delivery but that these adaptations revert slowly over time, with mothers' physical state after long intervals being similar to that of women who have never been pregnant (Zhu et al. 1999). Although this mechanism is not well understood, the risks of preeclampsia are similar for first-time mothers and women conceiving after a long interpregnancy interval of five years or more (Conde-Agudelo et al. 2005; Conde-Agudelo et al. 2007). No direct physiological pathways link birth spacing to health outcomes among men.

Stress of Childcare

The spacing between children might influence resource distribution in the family, caring conditions, and other related factors. Parents with closely spaced children, particularly when those children are young, might experience greater demands on their time and attention, greater stress and anxiety, fewer opportunities to rest and recover, less time to exercise, and a greater likelihood of gaining weight (Glazebrook et al. 2004; Hagen et al. 2013; Kravdal et al. 2020; Nomaguchi and Bianchi 2004; Reczek et al. 2014; Umberson et al. 2011; Wenze et al. 2015). All else being equal, a sparser birth schedule will spread out parental time commitments and stress over more years, reducing the intensity of parenting over that period. Thus, parents who raise closely spaced children may be more likely to have poor health than parents whose children are spaced further apart. The short-interval burden might be the heaviest for mothers. Although Norway is characterized by relatively gender-egalitarian parenting, generous parental leave, and heavily subsidized childcare, women still shoulder more responsibility for childcare than men (Bernhardt et al. 2008; Kitterød and Lappegård 2012; Sayer 2005).

Selection Processes

The preceding sections note several plausible mechanisms by which birth spacing may affect parental health. Nevertheless, birth spacing behavior is not randomly distributed, and parents who have children after particularly short or long birth intervals might differ from other parents in socioeconomic status, health, or other demographic characteristics—factors that also affect later mental and physical health. Data from the United States show that short birth intervals are more common among socioeconomically disadvantaged mothers, teenage mothers, and mothers who are racial or ethnic minorities; they are also more common among socioeconomically advantaged parents in their late 30s, who are presumably pursuing an accelerated fertility schedule following a delayed first birth (Gemmill and Lindberg 2013; Thagard et al. 2018). On the other hand, long birth intervals might result partly from partner changes. Although factors such as parental age at childbearing, socioeconomic status, partnership histories, and race and ethnicity are often measured in observational data, they might be imperfectly measured. Unobserved factors could also drive an association between birth spacing and parental health outcomes. For example, if an underlying health condition affects both fecundity and later health outcomes, women with longer birth intervals could have worse health later. We implement individual- and sibling-level fixed effects to adjust for unobserved factors that could drive any association between birth spacing and parental health outcomes.

Data and Methods

Data Sources

The study's data sources are the Norwegian Population Register, the Educational Database, and the Health Reimbursement register (*Kontroll og utbetaling av helserefusjoner register*, KUHR), the latter with information about GP consultations from 2006.[1] The data extractions for this analysis cover the period up to January 1, 2019.

All persons who ever lived in Norway after 1964 are included in the Population Register and assigned a personal identification number (PIN) that allows linkage to other registers. The Population Register includes information about the person's year and month of birth and death (if any), as well as marital and cohabitation status on January 1 each year from 2005 to 2019 (Falnes-Dalheim 2009). For 1975–2004, the register includes full information about marital status but not cohabitation. Because parents' PINs are included for almost everyone born in Norway after 1953, almost full histories of live births are available for women and men born after 1935. Furthermore, the data have annual information on whether the person lived in Norway on January 1 and their municipality of residence. Additionally, we extracted annual information on educational achievements from the Educational Database in Statistics Norway.

The outcome variable in this study is the annual number of face-to-face GP consultations for two main types of disease: mental diseases and physical diseases (excluding pregnancy-related diseases).[2] An important part of our analysis is examining the sensitivity of the conclusions to the choices of statistical approach and the time

[1] Primary health care personnel report consultations to KUHR to receive reimbursement from the state. Additionally, KUHR includes some consultations with specialists. In the data extracted for our analysis, 99.4% of the consultations are with physicians we can reasonably consider GPs. The few GPs without a contract with the health authorities, who therefore do not benefit from public subsidies, do not report to KUHR.

[2] Up to two diagnoses in the International Classification of Primary Care (ICPC-2) system are given for each consultation. (In 0.8% of the consultations, three or more diagnoses are given; we considered only the first two.). A consultation with at least one mental diagnosis (P70–P99) was considered to be due to a mental disease. If at least one diagnosis contained the digits 70–99 and the chapter was not P (mental diseases) or W (pregnancy-related diseases), the consultation was considered to be due to a physical disease.

window for health measurement. We study two short-term periods to see whether the influence of birth spacing on parental health differs between the immediate postpartum period and a later period. We examine effects 60–83 and 120–143 months after birth to test for potentially protracted or persistent effects of birth spacing on parental health. The entire follow-up period (i.e., 1–5, 6–11, 60–83, or 120–143 months) has to fall within January 1, 2006–December 31, 2018. Note that although GPs do not treat the most severe diseases, the use of specialized health care usually requires GP referrals. Thus, the indicators reflect a combination of severe and less severe conditions.

Statistical Analysis

We analyzed data on all women and men born in 1935 or later and who had at least one live birth during 1996–2017. Our description of the statistical analysis refers to mothers, but we conducted the same analysis for fathers, with corresponding variables defined accordingly (e.g., using paternal age rather than maternal age). We excluded mothers with one or more twin deliveries.

For every childbirth of parities 2–5 born in 1996–2017, we calculated the length of the mother's previous birth interval. This birth interval is represented by a categorical variable (6–11, 12–17, 18–23, 24–29, 30–35, 36–47, 48–59, 60–83, 84–119, or 120+ months).[3] We estimated various models to explore the relationship between birth intervals and the number of GP consultations in a specified time interval (e.g., 6–11 months after the birth). If the mother (or father) was not resident in Norway in each calendar year that includes at least one of the months during the specified time interval, we excluded the birth from the analysis (although we counted it along with other births when calculating birth order and birth interval lengths). Being resident in a calendar year was defined as being resident on January 1 of that year and the subsequent year. This apparently clumsy definition reflects that the data do not include more detailed residence histories. The meager number of birth intervals shorter than 6 months (which implies a new pregnancy immediately after birth and a subsequent premature birth) was excluded from the analysis.

Models

To examine the relationship between birth intervals and GP consultations for mental and physical health, we estimate linear regression models—some that include individual fixed effects and others that include sibling fixed effects. Our core research question, whether birth spacing affects parental health, contains two subquestions: whether birth spacing affects short-term parental health and whether birth spacing affects longer term parental health. We use individual fixed-effects models to try to

[3] Extremely short birth intervals are exceedingly rare. For example, in the analytic sample used for Model 1a, only two observations had a 6-month interval, six had a 7-month interval, 12 had an 8-month interval, and 37 had a 9-month interval. Intervals of 10 or 11 months are more common, but we observe only 193 and 745 instances, respectively.

isolate the net effect of birth spacing on the mother's and father's short-term outcomes by holding constant factors across births to the same mother or father. To study medium- and long-term physical and mental health, we apply sibling fixed effects (for same-sex maternal siblings) to adjust for mothers' and fathers' family background factors that might influence both birth spacing behavior and health.

Short-Term Outcomes

We first examine all births at parities 2–5 in 2006–2017 and the number of consultations the mother or father had in the 1–5 months after the birth. We estimate three models:

- *Model 1a* includes $\mathbf{X}_{ij}$ (parental age and birth parity) and uses the full sample of births during this period.
- *Model 1b* is based on the sample of parents for whom we have data on at least two births at parities 2–5 in the time window of our study (i.e., the within-individual fixed-effects sample), but individual fixed effects are not applied. This model adjusts for the vector of control variables **X** (as defined previously), as well as $\mathbf{Z}_{ij}$ (mother's educational level, mother's marital/cohabitation status, and whether the co-parent is the same as at the previous parity). Cohabitation status is measured on January 1 in the year that we start counting GP consultations for each index person, and parental education is measured on October 1 of the year preceding the year in which we count GP consultations for each index person. Therefore, parental education and cohabitation status are measured shortly before or after the index person gives birth or fathers the child. These control variables are time-varying to the extent that they change between births.
- *Model 1c* uses the same sample and control variables as Model 1b but adds individual fixed effects—that is, it compares a mother's outcomes following birth intervals at different parities.

Next, we continue our examination of all births at parities 2–5 in 2006–2017, but we change the outcome to the number of consultations 6–11 months after the birth. Again, we estimate three models: Models 2a, 2b, and 2c, which parallel Models 1a, 1b, and 1c.

In principle, the outcome (maternal health) could affect the exposure for the next-born child (the interval up to the birth of that child), referred to as the "carry-over problem" (Sjölander et al. 2016). In particular, mothers with relatively poor health after a birth might be less likely to have another child quickly (Margolis and Myrskylä 2015). However, the sibling model estimates of the effects of birth intervals on maternal health will be substantially biased only if this effect of health on subsequent fertility is extremely strong, which is unlikely (Kravdal 2020).

Medium- and Long-Term Outcomes

Finally, to look at medium- and long-term health outcomes, we consider mothers' and fathers' number of consultations for mental or physical diseases 60–83 months (5–6 years) or 120–143 months (10–11 years) after the last birth to the index parent.

For the medium- and long-term outcomes, we operationalize birth intervals as the average birth interval across all previous births. Our starting point for medium-term outcomes is all mothers (and fathers) with at least one child of parity 2+ aged 60–83 months during 2006–2018 (i.e., the children had to be born in 2001–2012). Similarly, for long-term outcomes, we study all mothers (and fathers) with at least one child of parity 2+ aged 120–143 months during 2006–2018 (i.e., the children had to be born in 1996–2007). We estimate three models for medium-term outcomes:

- *Model 3a* includes variables $\mathbf{X}_{ij}$ (birth parity and age at birth for the index parent).
- *Model 3b* is based on the sample we use for the sibling fixed-effects analysis but does not apply sibling fixed effects. That is, the sample includes mothers whose own mother's PIN is observed and who have at least one same-sex sibling with a birth as specified earlier (i.e., at least one child of parity 2+ aged 60–83 months during 2006–2018). Model 3b adjusts for the vector of control variables **X** (as defined previously) and adds the variables **Z** (also as defined earlier). These variables are measured at the beginning of the period over which we measure GP consultations (i.e., January 1 in the year of the first month of our study period).
- *Model 3c* uses the same sample and control variables as Model 3b but adds sibling fixed effects.

We conduct each analysis separately for mothers and fathers and separately for physical and mental health consultations. For long-term outcomes, we estimate three models: Models 4a, 4b, and 4c.

For each analysis, we present both unscaled and scaled regression coefficients, where the scaled coefficients are unscaled regression coefficients divided by the mean number of GP consultations for the specific combination of sex (women or men), outcome type (physical or mental health consultations), outcome measurement period (1–5, 6–11, 60–83, or 120–143 months after birth), and statistical modeling approach (fixed effects or not). We present scaled regression coefficients to emphasize the magnitude and substantive significance of the results. This scaling exercise is important given that care-seeking, for example, remains much less common for mental health than for physical ailments**.** In the results section, the tables present unscaled regression coefficients, and the figures present scaled regression coefficients.

Results

Descriptive Statistics

Table 1 shows the mean number of consultations in which a mental or physical issue is reported as a diagnosis, by birth interval length for men and women for each time window. Notably, seeking care for mental health is much less common than seeking care for physical health, but seeking care for both mental and physical issues is much more common in the long term than in the short term. The latter finding, however, likely reflects parental age effects. Across all study periods, mothers and fathers who

Table 1 Descriptive statistics for Norwegian mothers' and fathers' mean number of GP consultations for mental and physical issues in specific periods (1–5, 6–11, 60–83, and 120–143 months) after birth

		Average Number of Consultations for Mental Health Issues				Average Number of Consultations for Physical Health Issues			
		Full Sample		Fixed-Effects Sample		Full Sample		Fixed-Effects Sample	
Period	Interval	Mother	Father	Mother	Father	Mother	Father	Mother	Father
1–5 Months After Birth	6–11	0.088	0.096	0.094	0.099	0.701	0.608	0.716	0.611
	12–17	0.049	0.064	0.052	0.067	0.589	0.515	0.581	0.521
	18–23	0.039	0.048	0.038	0.054	0.550	0.460	0.544	0.574
	24–29	0.033	0.038	0.033	0.041	0.535	0.435	0.511	0.448
	30–35	0.033	0.041	0.033	0.039	0.545	0.425	0.533	0.438
	36–47	0.039	0.043	0.036	0.044	0.550	0.441	0.534	0.458
	48–59	0.044	0.049	0.038	0.054	0.555	0.460	0.553	0.467
	60–83	0.054	0.058	0.054	0.060	0.561	0.483	0.561	0.492
	84–119	0.063	0.069	0.061	0.065	0.571	0.508	0.564	0.511
	120+	0.070	0.085	0.057	0.070	0.594	0.561	0.551	0.519
	Total	0.044	0.051	0.041	0.051	0.555	0.463	0.543	0.471
6–11 Months After Birth	6–11	0.190	0.139	0.193	0.144	0.921	0.696	0.927	0.702
	12–17	0.098	0.074	0.102	0.078	0.740	0.617	0.739	0.633
	18–23	0.070	0.053	0.073	0.060	0.660	0.553	0.654	0.563
	24–29	0.059	0.048	0.057	0.054	0.625	0.525	0.607	0.538
	30–35	0.062	0.048	0.064	0.046	0.627	0.511	0.611	0.514
	36–47	0.065	0.053	0.065	0.057	0.621	0.523	0.622	0.547
	48–59	0.073	0.059	0.070	0.064	0.640	0.544	0.631	0.554
	60–83	0.090	0.073	0.090	0.073	0.647	0.574	0.662	0.581
	84–119	0.112	0.079	0.114	0.083	0.668	0.608	0.669	0.608
	120+	0.124	0.105	0.101	0.102	0.706	0.684	0.644	0.633
	Total	0.076	0.061	0.075	0.063	0.647	0.555	0.641	0.562
60–83 Months After Birth	6–11	1.056	0.478	1.357	0.393	4.137	2.802	4.667	3.098
	12–17	0.600	0.444	0.683	0.380	3.366	2.463	3.331	2.257
	18–23	0.472	0.273	0.448	0.281	3.061	2.185	2.918	1.924
	24–29	0.465	0.273	0.435	0.198	2.951	2.081	2.813	1.970
	30–35	0.441	0.259	0.431	0.228	2.914	2.097	2.837	1.968
	36–47	0.491	0.272	0.469	0.243	3.084	2.206	2.946	2.090
	48–59	0.599	0.339	0.584	0.277	3.382	2.439	3.276	2.223
	60–83	0.715	0.388	0.669	0.346	3.639	2.694	3.593	2.545
	84–119	0.800	0.414	0.790	0.412	3.894	2.977	3.879	2.806
	120+	0.838	0.489	0.884	0.453	4.273	3.418	4.216	3.187
	Total	0.561	0.319	0.535	0.276	3.261	2.380	3.139	2.200
120–143 Months After Birth	6–11	1.013	0.555	0.192	0.169	3.982	2.858	4.308	3.153
	12–17	0.704	0.398	0.621	0.321	3.460	2.544	3.422	2.485
	18–23	0.539	0.309	0.513	0.296	3.061	2.369	2.823	2.212
	24–29	0.475	0.305	0.458	0.239	3.007	2.242	2.856	2.066
	30–35	0.465	0.263	0.421	0.218	3.048	2.256	2.915	2.063
	36–47	0.501	0.281	0.468	0.232	3.222	2.396	3.104	2.228
	48–59	0.604	0.317	0.570	0.255	3.538	2.594	3.360	2.386
	60–83	0.684	0.387	0.665	0.353	3.815	2.908	3.729	2.675
	84–119	0.788	0.444	0.799	0.389	4.131	3.304	4.195	3.093
	120+	0.867	0.476	0.924	0.472	4.441	3.731	4.282	3.282
	Total	0.578	0.327	0.548	0.276	3.413	2.581	3.282	2.367

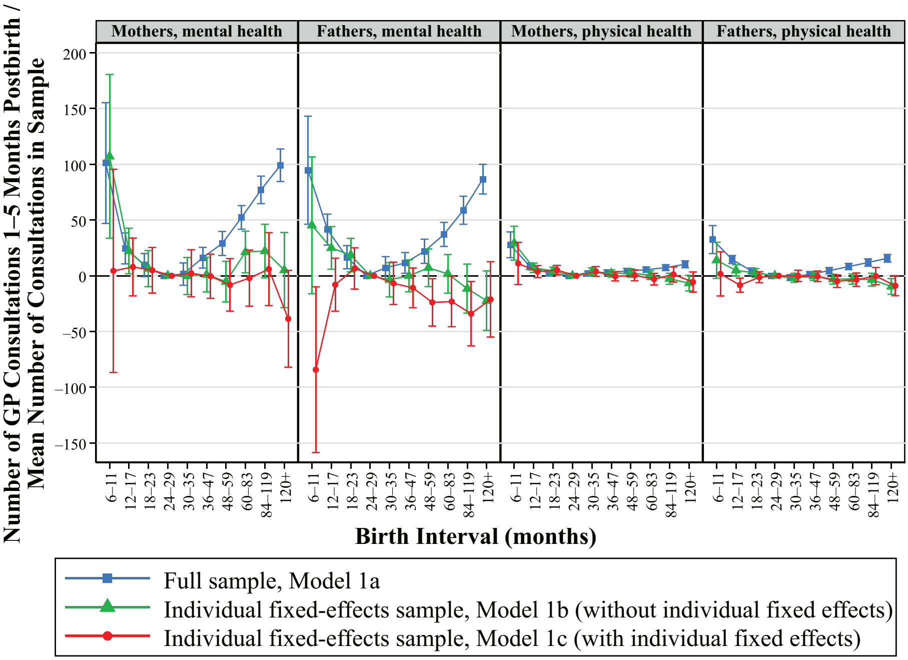

Fig. 1 The relationship between birth intervals and Norwegian mothers' and fathers' number of GP consultations for mental and physical health 1–5 months after birth. The coefficients are scaled by the mean number of consultations in the analytic sample.

experience extremely short birth intervals (6–11 months) have the highest probability of seeking care, although care-seeking is also relatively more common among mothers and fathers who experience a long birth interval of 120+ months. Further descriptive information on the distribution of each covariate is available in Tables S1–S4 (online appendix).

Short-Term Outcomes (1–5 and 6–11 months after birth)

Figure 1 and Table 2 show the results for men and women for consultations for both mental and physical issues 1–5 months after birth. Figure 2 and Table 3 show the corresponding results for 6–11 months after birth. Clear and consistent patterns are evident. The results from Models 1a and 2a—which include minimal control variables, are based on the full sample, and do not apply fixed effects—show a U- or J-shaped curve: short birth intervals (particularly <18 months) and long birth intervals (particularly >47 months) are associated with more GP consultations. Models 1b and 2b introduce additional control variables and use the individual fixed-effects sample but do not apply individual fixed effects. These models tend to show an association between short birth intervals and more GP consultations but reveal a much weaker association between long birth intervals and GP consultations.

Our key analyses are those that employ individual fixed effects: Models 1c and 2c. The results from these fixed-effects analyses show much smaller associations

Table 2 The relationship between birth intervals and Norwegian mothers' and fathers' number of GP consultations for mental and physical health issues 1–5 months after birth: Coefficients and 95% confidence intervals (CI)

		Mental Health						Physical Health					
		Model 1a		Model 1b		Model 1c		Model 1a		Model 1b		Model 1c	
Sex	Interval	*b*	95% CI	*b*	95% CI	*b*	95% CI	*b*	95% CI	*b*	95% CI	*b*	95% CI
Male	6–11	0.048	.024, .073	0.013	.003, .022	–0.043	–.080, –.005	0.150	.092, .208	0.065	–.011, .141	0.008	–.085, .101
	12–17	0.021	.014, .028	0.009	.002, .017	–0.004	–.016, .008	0.067	.051, .084	0.023	–.001, .046	–0.040	–.069, –.009
	18–23	0.008	.003, .014	0.000		0.003	–.006, .018	0.020	.007, .032	0.012	–.007, .031	–0.006	–.029, .017
	24–29 (ref.)	0.000		–0.002	–.010, .006	0.000		0.000		0.000		0.000	
	30–35	0.004	–.001, .009	0.000	–.007, .007	–0.003	–.013, .006	–0.008	–.019, .004	–0.009	–.028, .010	–0.001	–.024, .023
	36–47	0.006	.001, .011	0.004	–.005, .012	–0.006	–.014, .004	0.006	–.004, .017	–0.002	–.020, .015	–0.002	–.024, .020
	48–59	0.011	.006, .017	0.001	–.008, .010	–0.012	–.023, –.001	0.021	.008, .034	–0.015	–.036, .006	–0.023	–.049, .004
	60–83	0.019	.013, .024	–0.006	–.017, .005	–0.012	–.023, –.000	0.038	.025, .051	–0.014	–.035, .007	–0.017	–.045, .012
	84–119	0.030	.024, .036	–0.011	–.025, .002	–0.017	–.032, –.002	0.055	.040, .070	–0.017	–.044, .011	–0.002	–.037, .035
	120+	0.044	.037, .051	0.013	.003, .022	–0.011	–.028, .006	0.072	.057, .088	–0.045	–.078, –.012	–0.042	–.084, .000
	N	390,003		155,772		155,772		390,003		155,772		155,772	
Female	6–11	0.044	.021, .068	0.044	.014, .074	0.002	–.035, .039	0.154	.090, .218	0.158	.076, .241	0.060	–.042, .162
	12–17	0.011	.005, .017	0.009	.001, .017	0.003	–.007, .014	0.047	.031, .064	0.039	.016, .062	0.020	–.009, .049
	18–23	0.004	–.000, .009	0.003	–.004, .009	0.002	–.006, .010	0.012	.000, .025	0.024	.005, .042	0.027	.004, .050
	24–29 (ref.)	0.000		0.000		0.000		0.000		0.000		0.000	
	30–35	0.001	–.003, .005	0.000	–.007, .007	0.001	–.007, .010	0.011	–.000, .023	0.020	.001, .038	0.021	–.003, .044
	36–47	0.007	.003, .011	0.000	–.006, .007	0.000	–.008, .008	0.018	.007, .029	0.011	–.006, .029	–0.003	–.025, .019
	48–59	0.013	.008, .017	–0.002	–.010, .005	–0.003	–.013, .006	0.023	.010, .036	0.013	–.008, .033	0.002	–.024, .029
	60–83	0.023	.018, .028	0.009	.001, .016	–0.001	–.011, .009	0.030	.017, .043	0.003	–.018, .024	–0.017	–.044, .012
	84–119	0.034	.028, .039	0.009	–.001, .019	0.002	–.010, .016	0.040	.026, .055	–0.015	–.042, .012	0.006	–.030, .043
	120+	0.044	.037, .050	0.002	–.012, .016	–0.016	–.033, .002	0.057	.040, .074	–0.036	–.074, .002	–0.030	–.079, .018
	N	396,502		151,374		151,374		396,502		151,374		151,374	

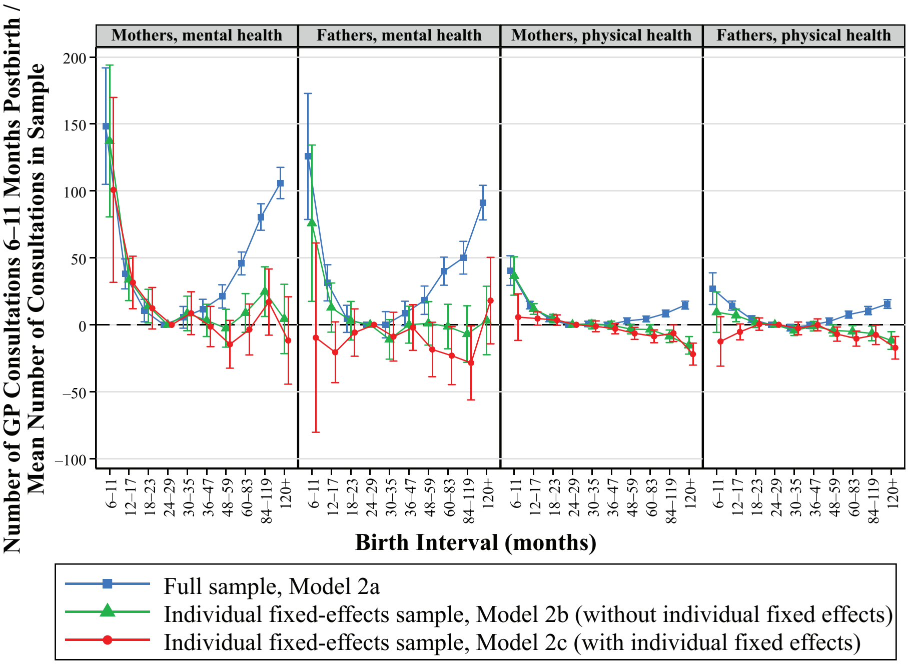

Fig. 2 The relationship between birth intervals and Norwegian mothers' and fathers' number of GP consultations for mental and physical health 6–11 months after birth. The coefficients are scaled by the mean number of consultations in the analytic sample.

between birth interval length and GP consultations in both absolute terms (see Tables 2 and 3) and relative terms (see Figures 1 and 2, where the regression coefficient is divided by the mean number of GP consultations, shown in Table 1). Indeed, the results from Models 1c and 2c generally suggest little to no relationship between birth interval length and GP consultations in terms of substantive and statistical significance, with a few exceptions. For example, short birth intervals are associated with more GP consultations for mental health for mothers in the 6–11 months after birth. In absolute terms, this difference is small (only 0.076 more GP consultations relative to the reference category). However, given that the baseline number of mothers' GP consultations for mental health 6–11 months after birth is 0.075 in the analytic sample, it is large in relative terms. We also see some suggestion that longer birth intervals are associated with fewer GP consultations for physical health 6–11 months after birth for mothers and fathers and that both shorter and longer intervals might be associated with fewer GP consultations of either kind for fathers 5–11 months after birth.

Medium-Term Outcomes (5–6 years after birth)

Figure 3 and Table 4 show the relationship between birth intervals and mothers' and fathers' frequency of GP consultations for mental and physical health issues 5–6 years after birth. Model 3a uses the full sample with minimal controls, Model 3b employs

Table 3 The relationship between birth intervals and Norwegian mothers' and fathers' number of GP consultations for mental and physical health issues 6–11 months after birth: Coefficients and 95% confidence intervals (CI)

		Mental Health						Physical Health					
		Model 2a		Model 2b		Model 2c		Model 2a		Model 2b		Model 2c	
Sex	Interval	*b*	95% CI	*b*	95% CI	*b*	95% CI	*b*	95% CI	*b*	95% CI	*b*	95% CI
Male	6–11	0.077	.048, .105	0.048	.011, .085	–0.006	–.050, .039	0.150	.084, .215	0.053	–.032, .138	–0.070	–.173, .034
	12–17	0.019	.011, .027	0.008	–.003, .020	–0.013	–.027, .001	0.079	.061, .098	0.039	.013, .066	–0.030	–.063, .004
	18–23	0.003	–.003, .009	0.002	–.007, .011	–0.004	–.014, .007	0.023	.009, .037	0.009	–.011, .030	0.003	–.023, .029
	24–29 (ref.)	0.000		0.000		0.000		0.000		0.000		0.000	
	30–35	0.000	–.005, .006	–0.007	–.016, .002	–0.006	–.017, .006	–0.012	–.025, .002	–0.024	–.045, –.002	–0.015	–.041, .012
	36–47	0.005	–.000, .011	0.000	–.009, .009	–0.001	–.012, .009	–0.002	–.015, .010	–0.006	–.026, .014	0.000	–.025, .025
	48–59	0.011	.005, .018	0.001	–.010, .011	–0.012	–.024, .001	0.014	–.001, .028	–0.023	–.047, .000	–0.039	–.069, –.009
	60–83	0.024	.018, .031	–0.001	–.011, .010	–0.015	–.028, –.000	0.042	.028, .057	–0.028	–.052, –.004	–0.058	–.089, –.026
	84–119	0.031	.023, .038	–0.004	–.018, .009	–0.018	–.035, –.000	0.059	.042, .076	–0.036	–.067, –.006	–0.043	–.083, –.001
	120+	0.056	.048, .064	0.002	–.014, .018	0.011	–.008, .032	0.086	.068, .104	–0.066	–.103, –.029	–0.097	–.143, –.049
	N	388,653		156,021		156,021		388,653		156,021		156,021	
Female	6–11	0.113	.080, .146	0.103	.060, .146	0.076	.024, .127	0.262	.190, .334	0.233	.142, .325	0.036	–.075, .148
	12–17	0.029	.020, .037	0.025	.014, .037	0.024	.009, .038	0.095	.077, .113	0.076	.050, .101	0.030	–.001, .062
	18–23	0.008	.002, .014	0.010	.001, .020	0.009	–.002, .021	0.029	.015, .042	0.030	.010, .050	0.022	–.002, .047
	24–29 (ref.)	0.000		0.000		0.000		0.000		0.000		0.000	
	30–35	0.004	–.001, .010	0.006	–.003, .016	0.006	–.005, .018	0.004	–.009, .017	0.001	–.019, .022	–0.007	–.033, .019
	36–47	0.009	.003, .014	0.002	–.007, .012	–0.001	–.012, .010	0.000	–.011, .013	–0.002	–.022, .018	–0.019	–.043, .005
	48–59	0.016	.010, .023	–0.002	–.013, .009	–0.011	–.024, .002	0.019	.005, .033	–0.020	–.043, .002	–0.041	–.069, –.012
	60–83	0.035	.028, .041	0.007	–.004, .017	–0.003	–.016, .012	0.028	.014, .042	–0.023	–.046, .001	–0.055	–.085, –.024
	84–119	0.061	.054, .069	0.019	.005, .032	0.013	–.005, .031	0.055	.038, .071	–0.055	–.085, –.025	–0.040	–.080, –.000
	120+	0.080	.072, .089	0.003	–.016, .023	–0.009	–.033, .016	0.095	.076, .114	–0.098	–.140, –.057	–0.140	–.193, –.087
	N	395,175		151,672		151,672		395,175		151,672		151,672	

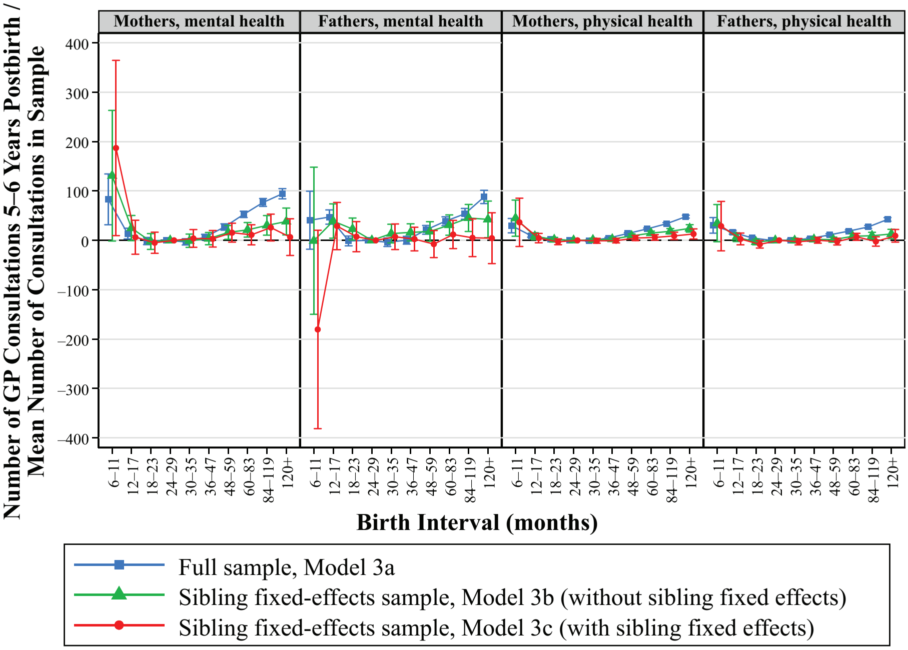

Fig. 3 The relationship between birth intervals and Norwegian mothers' and fathers' number of GP consultations for mental and physical health 5–6 years after birth. The coefficients are scaled by the mean number of consultations in the analytic sample.

additional controls but still avoids fixed effects, and Model 3c includes sibling fixed effects to control for unobserved heterogeneity in the family of origin.

For fathers, Model 3a generally shows a pattern of association between longer birth intervals (particularly >60 months) and increased GP consultations for mental and physical health. However, when we introduce additional controls and fixed effects in Models 3b and 3c, the relationships become less clear and sometimes change direction. Specifically, Model 3c indicates limited associations between birth intervals and GP consultations, with a few intervals showing a negative relationship. Thus, unobserved shared family background factors might influence the association between birth spacing and parents' later health outcomes.

For mothers, the results are more nuanced. Model 3a shows a substantial association between short birth intervals (6–11 months) and more GP consultations for mental health. This trend remains consistent but decreases in magnitude in Models 3b and 3c. In Model 3c, which adds sibling fixed effects, mothers have 1.144 additional visits to a GP for mental health concerns relative to the reference category—a considerable relative difference, given that the mean number of consultations in this sample is 0.535. For physical health, GP consultations increase for longer birth intervals (particularly 60–83 and 84–119 months) across all models. Interestingly, Model 3c, which includes sibling fixed effects, shows only modest associations for mental health but maintains a somewhat consistent relationship for physical health consultations for parents with longer birth intervals. What stands out most is the attenuating effect of sibling fixed effects on the relationship between birth intervals and GP

Table 4 The relationship between birth intervals and Norwegian mothers' and fathers' number of GP consultations for mental and physical health issues 5–6 years after birth: Coefficients and 95% confidence intervals (CI)

		Mental Health						Physical Health					
		Model 3a		Model 3b		Model 3c		Model 3a		Model 3b		Model 3c	
Sex	Interval	*b*	95% CI	*b*	95% CI	*b*	95% CI	*b*	95% CI	*b*	95% CI	*b*	95% CI
Male	6–11	0.130	–.057, .317	–0.002	–.414, .409	–0.498	–.053, .056	0.722	.346, .098	0.767	–.062, .595	0.633	–.468, .734
	12–17	0.151	.104, .197	0.108	.012, .204	0.080	–.052, .212	0.391	.298, .483	0.138	–.055, .331	0.061	–.201, .324
	18–23	–0.004	–.035, .028	0.063	.002, .125	0.020	–.064, .105	0.115	.052, .179	–0.074	–.197, .050	–0.178	–.345, –.011
	24–29 (ref.)	0.000		0.000		0.000		0.000		0.000		0.000	
	30–35	–0.012	–.040, .015	0.038	–.015, .090	0.020	–.052, .092	0.009	–.046, .064	–0.007	–.112, .099	–0.062	–.204, .080
	36–47	0.001	–.024, .026	0.044	–.003, .092	0.007	–.059, .073	0.088	.038, .139	0.044	–.052, .141	0.003	–.128, .135
	48–59	0.068	.040, .096	0.050	–.005, .104	–0.021	–.097, .055	0.262	.206, .319	0.032	–.078, .142	–0.056	–.206, .094
	60–83	0.124	.095, .152	0.085	.029, .142	0.033	–.046, .111	0.447	.390, .504	0.181	.067, .296	0.156	–.001, .312
	84–119	0.171	.136, .206	0.125	.049, .201	0.014	–.091, .120	0.645	.575, .715	0.206	.053, .358	–0.051	–.260, .158
	120+	0.280	.238, .323	0.117	.015, .220	0.012	–.130, .154	1.009	.923, .095	0.284	.078, .490	0.203	–.079, .485
	N	250,956		52,356		52,487		52,356		52,487		52,356	
Female	6–11	0.466	.177, .754	0.700	–.008, .408	1.001	.051, .950	0.968	.493, .443	1.410	.260, .560	1.144	–.392, .681
	12–17	0.077	.016, .138	0.133	–.003, .269	0.034	–.151, .218	0.311	.211, .411	0.260	.039, .482	0.141	–.157, .439
	18–23	–0.008	–.049, .033	–0.013	–.098, .073	–0.026	–.141, .088	0.083	.016, .150	0.044	–.095, .184	–0.093	–.278, .092
	24–29 (ref.)	0.000		0.000		0.000		0.000		0.000		0.000	
	30–35	–0.017	–.053, .018	–0.004	–.076, .068	0.021	–.075, .117	–0.024	–.082, .034	0.028	–.089, .145	–0.031	–.186, .125
	36–47	0.036	.004, .068	0.019	–.048, .085	0.017	–.073, .107	0.149	.096, .202	0.077	–.031, .184	–0.020	–.165, .124
	48–59	0.151	.115, .187	0.086	.011, .161	0.083	–.019, .186	0.453	.394, .512	0.285	.163, .407	0.147	–.019, .312
	60–83	0.295	.259, .331	0.114	.035, .193	0.060	–.049, .169	0.755	.696, .815	0.459	.330, .587	0.184	.008, .361
	84–119	0.430	.386, .475	0.162	.056, .268	0.139	–.007, .284	1.097	.023, .171	0.576	.404, .748	0.284	.049, .519
	120+	0.530	.472, .588	0.204	.059, .350	0.035	–.164, .234	1.565	.469, .660	0.760	.523, .996	0.405	.083, .727
	N	260,916		56,227		56,227		260,916		56,227		56,227	

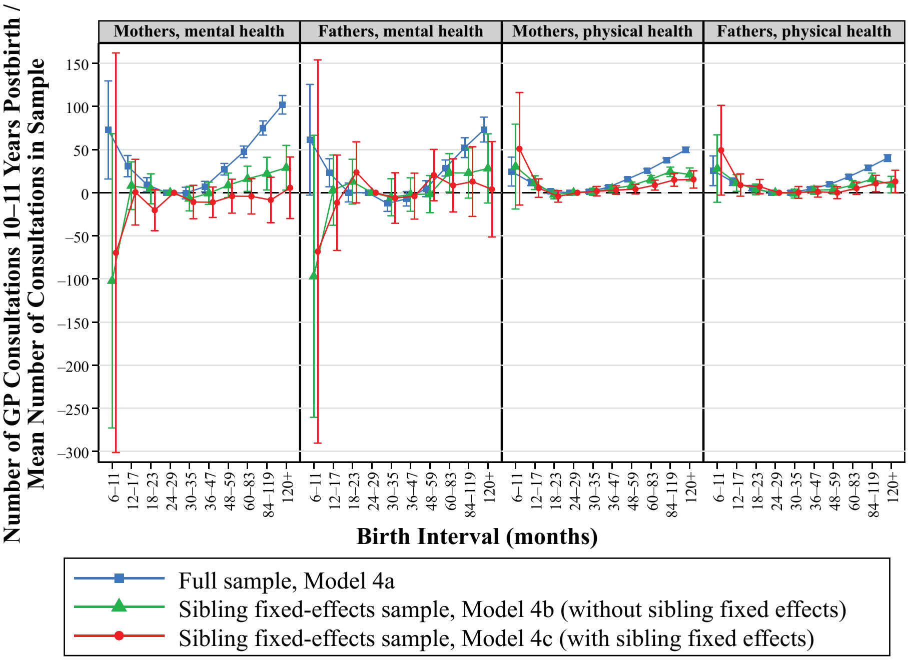

Fig. 4 The relationship between birth intervals and Norwegian mothers' and fathers' number of GP consultations for mental and physical health 10–11 years after birth. The coefficients are scaled by the mean number of consultations in the analytic sample.

consultations. Once shared family background characteristics are controlled for in Model 3c, the relationship weakens considerably, suggesting that unobserved factors play a significant role.

Long-Term Outcomes (10–11 years after birth)

The results presented in Figure 4 and Table 5 are based on analyses examining the long-term impact of birth intervals on mothers' and fathers' frequency of GP consultations for mental and physical health. This examination employs three distinct models for both sexes and both types of health. Model 4a utilizes the full sample with minimum controls, Model 4b adds more controls but avoids fixed effects, and Model 4c includes sibling fixed effects to control for family-based unobserved heterogeneity.

For fathers, the results from Model 4a indicate a positive relationship between short birth intervals (6–11 months) and physical health consultations. This association remains somewhat consistent across Models 4a, 4b, and 4c but increases in Model 4c. Findings for Model 4c suggest that shorter intervals might have a lasting impact on fathers' physical health, although these differences are not statistically significant. The relationships for mental health are less consistent across models. Further, the coefficients generally decrease with additional controls and fixed effects, indicating that family background factors might confound the associations. For mothers, the results from Model 4a indicate significant associations between both

Table 5 The relationship between birth intervals and Norwegian mothers' and fathers' number of GP consultations for mental and physical health issues 10–11 years after birth: Coefficients and 95% confidence intervals (CI)

		Mental Health						Physical Health					
		Model 4a		Model 4b		Model 4c		Model 4a		Model 4b		Model 4c	
Sex	Interval	*b*	95% CI	*b*	95% CI	*b*	95% CI	*b*	95% CI	*b*	95% CI	*b*	95% CI
Male	6–11	0.201	–.009, .411	–0.267	–.719, .184	–0.188	–.801, .425	0.657	.212, 1.101	0.664	–.262, 1.590	1.167	–.064, 2.397
	12–17	0.076	.023, .129	0.008	–.104, .121	–0.032	–.184, .120	0.329	.216, .442	0.268	.037, .499	0.210	–.095, .517
	18–23	0.001	–.035, .037	0.035	–.036, .107	0.065	–.032, .163	0.142	.066, .217	0.091	–.056, .238	0.168	–.028, .364
	24–29 (ref.)	0.000		0.000		0.000		0.000		0.000		0.000	
	30–35	–0.041	–.070, –.010	–0.014	–.074, .045	–0.017	–.097, .064	–0.001	–.065, .063	–0.023	–.145, .099	0.008	–.153, .171
	36–47	–0.023	–.050, .004	–0.006	–.059, .048	–0.011	–.084, .063	0.109	.051, .167	0.068	–.042, .178	0.027	–.120, .175
	48–59	0.015	–.014, .045	–0.004	–.064, .055	0.056	–.025, .139	0.248	.183, .312	0.087	–.035, .209	0.002	–.162, .167
	60–83	0.094	.063, .124	0.064	.003, .125	0.024	–.061, .109	0.479	.414, .543	0.207	.081, .333	0.122	–.048, .293
	84–119	0.171	.133, .208	0.063	–.017, .143	0.036	–.075, .147	0.746	.666, .826	0.375	.210, .539	0.253	.030, .477
	120+	0.239	.192, .287	0.078	–.033, .189	0.011	–.141, .164	1.036	.936, 1.136	0.222	–.006, .449	0.309	.003, .616
	N	233,842		52,487		52,487		233,842		52,487		52,487	
Female	6–11	0.421	.092, .749	–0.560	–1.495, .375	–0.381	–1.65, .888	0.836	.264, 1.41	0.994	–.620, 2.608	1.673	–.468, 3.813
	12–17	0.178	.107, .249	0.045	–.107, .196	0.004	–.205, .212	0.404	.281, .528	0.384	.122, .645	0.177	–.175, .529
	18–23	0.054	.008, .101	0.025	–.070, .120	–0.111	–.241, .019	0.051	–.029, .132	–0.067	–.232, .097	–0.140	–.359, .080
	24–29 (ref.)	0.000		0.000		0.000		0.000		0.000		0.000	
	30–35	–0.002	–.041, .037	–0.037	–.115, .040	–0.059	–.165, .047	0.045	–.022, .113	0.036	–.099, .170	0.059	–.119, .239
	36–47	0.041	.006, .076	–0.004	–.074, .067	–0.060	–.157, .037	0.219	.158, .280	0.157	.035, .279	0.101	–.062, .264
	48–59	0.157	.119, .196	0.047	–.030, .125	–0.022	–.129, .086	0.542	.475, .609	0.273	.138, .407	0.137	–.045, .318
	60–83	0.274	.235, .313	0.088	.008, .169	–0.023	–.135, .090	0.875	.808, .943	0.516	.378, .654	0.289	.100, .479
	84–119	0.434	.386, .481	0.121	.017, .225	–0.046	–.190, .098	1.286	1.203, 1.368	0.796	.617, .975	0.489	.245, .732
	120+	0.589	.527, .651	0.159	.017, .301	0.032	–.163, .227	1.699	1.590, 1.806	0.698	.453, .943	0.507	.177, .836
	N	247,410		58,512		58,512		247,410		58,512		58,512	

short and long birth intervals and increased GP consultations for mental and physical health. However, the introduction of additional controls in Model 4b and sibling fixed effects in Model 4c attenuates these relationships, particularly for mental health. Thus, shared family characteristics and other unobserved factors might play a role in these associations.

Interestingly, for both mothers and fathers, the relationship with birth intervals seems more robust for physical health than for mental health. Even with the introduction of additional controls and sibling fixed effects, the direction of the associations generally remains the same, especially for longer birth intervals (84–119 months and 120+ months).

Supplementary Analyses

The preceding results raise a question regarding the extent to which the differences between the a and b models are attributable to changes in the analytic sample (i.e., comparing the full sample with the fixed-effects sample) and how much they are attributable to changing the control variables. In supplementary analyses, we run Model 1a on both the full sample and the fixed-effects sample; we do the same for Models 2a, 3a, and 4a. Overall, these comparisons reveal remarkably similar results, suggesting that the differences we observe are not due to changes in the analytic sample.

Discussion

In this study, we add to the growing literature on the effects of birth spacing on parents' and children's health and well-being. To our knowledge, ours is one of the first studies to use both an individual and sibling fixed-effects approach to adjust for unobserved characteristics that might be related to both birth spacing behavior and later health outcomes to try to isolate the net effect of birth spacing. Furthermore, we extend the literature by applying this approach to both physical and mental health outcomes; examining these outcomes in the short, medium, and long term; and exploring outcomes for both mothers and fathers. The results from our associational analyses, not holding constant the individual-level or sibling-group-level factors, are broadly in line with previous research on this topic (which has been restricted mostly to controlling for only observed characteristics): mothers and fathers seem to have worse health outcomes if they experience short or long intervals between births.

The results from our various fixed-effects analyses are more ambiguous: in models that hold constant either individual-level or family background characteristics, the adverse effects of short and long birth intervals are much smaller than those estimated in our naive models, but they are not zero. The strongest pattern that we observe suggests support for a plausibly adverse causal effect of very short intervals on mothers' mental health, perhaps related to increased stress from raising tightly spaced children; this pattern is observable for mental health 6–11 months and 5–6 years after birth. We also find evidence suggesting that longer birth intervals may be protective for mothers' and fathers' mental health in the short-term after birth, but the lack of consistency in the findings for the separate analyses of the periods 1–5 and 6–11 months after birth suggests that we should be cautious about overinterpreting these results. The similar findings for men and for women in both fixed-effects models and other models are noteworthy, particularly given that the hypothesized mechanisms linking spacing to later health outcomes give us reason to expect large sex differences in physiological effects and day-to-day childrearing effects.

Our analysis of long-term outcomes shows that very short and longer average birth intervals increase the probability of care-seeking for physical health problems. The similarity of the patterns for men and women suggests that the results might be driven by the stress of raising closely spaced children rather than negative consequences related to perinatal outcomes directly associated with the pregnancy. Alternatively, it might suggest that similar selection processes for men and women produce similar results for the relationship between birth spacing and long-term health. The negative effect of long birth intervals in these analyses is also plausibly related to the lesser effectiveness of sibling fixed effects in controlling for unobserved factors related to spacing behavior and health relative to individual-level fixed effects. These sibling comparison models should arguably be seen as providing a more effective control for family background factors than the individual fixed-effects models, which adjust for all stable individual-level factors.

In the literature using sibling fixed effects to estimate the influence of birth spacing on medium- and long-term *child* outcomes, the negative effects of birth spacing seem to be largely explained by various forms of confounding (Barclay and Kolk 2017, 2018; Barclay and Smith 2022). In contrast, we uncover evidence that short and long birth intervals, in particular, might negatively impact parental health, even after holding constant unobserved factors at the individual level and in the family of origin. However, we suggest caution and advise against an overinterpretation of the findings given that the absolute differences remain very small. Our results are somewhat consistent with previous research by Hanley et al. (2017) but not Liu et al. (2021). These studies also used within-mother estimators to examine the relationship between birth spacing and several specific health outcomes, including gestational diabetes, preeclampsia, beginning the following pregnancy obese (Hanley et al. 2017), and SMM (Liu et al. 2021). However, any comparison between our findings and those two studies must take into account the outcomes considered. They examined acute health outcomes, whereas our health measure reflects a mixture of acute and nonacute mental and physical health issues diagnosed by a GP, except for those issues judged to be pregnancy complications or pregnancy-related (i.e., chapter W in the International Classification of Primary Care [ICPC-2][4]). Further work on this topic that examines different outcomes in different periods after birth and across different countries is needed.

[4] Such issues include: W70 Puerperal infection/sepsis; W71 Infection complicating pregnancy; W72 Malignant neoplasm related to pregnancy; W73 Benign/unspec. neoplasm/pregnancy; W75 Injury complicating pregnancy; W76 Congenital anomaly complicate pregnancy; W78 Pregnancy; W79 Unwanted pregnancy; W80 Ectopic pregnancy; W81 Toxaemia of pregnancy; W82 Abortion spontaneous; W83 Abortion induced; W84 Pregnancy high risk; W85 Gestational diabetes; W90 Uncomplicate labour/delivery live; W91 Uncomplicate labour/delivery still; W92 Complicate labour/delivery livebirth; W93 Complicate labour/delivery stillbirth; W94 Puerperal mastitis; W95 Breast disorder in pregnancy other; W96 Complications of puerperium other; and W99 Disorder pregnancy/delivery, other.

A potential problem with our models examining health outcomes 6–11 months after childbirth is that there may already be a new pregnancy (which is much less likely when studying outcomes 1–5 months after delivery). The chance of such a pregnancy could be affected by the mother's health (leading to the aforementioned carry-over problem in a sibling analysis), but a pregnancy may also *affect* the mother's health within the 6- to 11-month period (even if pregnancy-related diseases are not counted)—causality may run both ways. In the presence of such an effect of an ongoing pregnancy on the mother's health and also an effect of a short previous interval on the chance of getting pregnant again as quickly as within 6–11 months, the ongoing pregnancy would be mediating the effect of the previous birth interval length on mother's health. In principle, then, one might want to control for the ongoing pregnancy to account for that pathway to determine a more direct effect. Alternatively, the previous birth interval length and the chance of an ongoing pregnancy might be noncausally linked (produced by joint determinants), making controlling for the latter even more important. However, one should be careful about controlling for the ongoing pregnancy in this situation with a possible two-way causality between pregnancy and the mother's health, which might lead to so-called collider bias. More specifically, if both the mother's health and the previous interval or its determinants affect the chance of an ongoing pregnancy, controlling for the latter produces an additional link between the previous birth interval and the mother's health, which constitutes the collider bias.

The relative degree to which our outcome measure captures health versus differences in health-seeking behavior requires reflection. Although this concern is legitimate, perhaps particularly in relation to mental health, the individual-level fixed effects should be an effective tool for holding constant the inclination to seek professional help for a health problem. The sibling comparison models might also be effective, albeit to a lesser extent. Our individual fixed-effects models do not implicitly adjust for factors that vary over time. However, we explicitly adjust for parity, education, marital status, and change of co-parent to the extent that those factors vary between births.

As noted earlier, the ACOG advises mothers to wait at least 6 months between pregnancies (ACOG 2019). Overall, we do not find strong evidence to support the ACOG's recommendation for the outcomes we study (i.e., GP consultations for mental or physical health concerns). Nevertheless, some of our analyses suggest mildly worse outcomes for mothers who give birth after very short birth intervals. Further, the ACOG recommendation could be valid for such maternal health outcomes as adverse pregnancy outcomes (Conde-Agudelo et al. 2007). Therefore, further research that accounts for unobserved individual heterogeneity is needed before physicians and potential mothers discard the ACOG's recommendations.

Despite some limitations, our study makes an important contribution to the literature. We provide "more causal" estimates that better adjust for more unobservable factors than previous research on this topic. Our results generally suggest that parents with particularly short or long intervals between births might have more health issues than parents with birth intervals of approximately 18–30 months, but they principally indicate that the strongest effects are concentrated around the negative effects of short intervals on mothers' mental health. We urge caution in generalizing these findings beyond the Norwegian context. Norway has a generous welfare state that provides excellent prenatal care and highly subsidized childcare, which could moderate the adverse effects of very short or long birth intervals. Nevertheless, our observation of some negative effects of birth spacing in a context providing substantial support for parents suggests that the negative effects of more extreme birth spacing might be worse in less generous contexts. We address the effect of birth spacing on general health following a pregnancy, including the long-term effects of pregnancy complications. However, our analysis is less appropriate for understanding whether birth intervals directly affect pregnancy complications, a topic that has been central in much previous research on the negative health consequences of short birth intervals. Further work, particularly additional analyses of high-quality population-level data using methods that can adjust for unobserved heterogeneity, is essential for further developing our understanding of the effects of spacing behavior on parental health. ■

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References

Ahrens, K. A., Hutcheon, J. A., Ananth, C. V., Basso, O., Briss, P. A., Ferré, C. D., . . . Moskosky, S. (2019). Report of the Office of Population Affairs' expert work group meeting on short birth spacing and adverse pregnancy outcomes: Methodological quality of existing studies and future directions for research. *Paediatric and Perinatal Epidemiology, 33,* O5–O14. https://doi.org/10.1111/ppe.12504

American College of Obstetricians and Gynecologists. (2019). Obstetric Care Consensus No. 8 summary: Interpregnancy care. *Obstetrics & Gynecology, 133,* 220–225.

Appareddy, S., Pryor, J., & Bailey, B. (2017). Inter-pregnancy interval and adverse outcomes: Evidence for an additional risk in health disparate populations. *Journal of Maternal-Fetal and Neonatal Medicine, 30,* 2640–2644.

Barclay, K., Keenan, K., Grundy, E., Kolk, M., & Myrskylä, M. (2016). Reproductive history and post-reproductive mortality: A sibling comparison analysis using Swedish register data. *Social Science & Medicine, 155,* 82–92.

Barclay, K. J., & Kolk, M. (2017). The long-term cognitive and socioeconomic consequences of birth intervals: A within-family sibling comparison using Swedish register data. *Demography, 54,* 459–484.

Barclay, K. J., & Kolk, M. (2018). Birth intervals and health in adulthood: A comparison of siblings using Swedish register data. *Demography, 55,* 929–955.

Barclay, K., & Smith, K. R. (2022). Birth spacing and health and socioeconomic outcomes across the life course: Evidence from the Utah Population Database. *Demography, 59,* 1117–1142. https://doi.org/10.1215/00703370-10015020

Berg, V., Miettinen, A., Jokela, M., & Rotkirch, A. (2020). Shorter birth intervals between siblings are associated with increased risk of parental divorce. *PLoS One, 15,* e0228237. https://doi.org/10.1371/journal.pone.0228237

Bernhardt, E., Noack, T., & Lyngstad, T. H. (2008). Shared housework in Norway and Sweden: Advancing the gender revolution. *Journal of European Social Policy, 18,* 275–288.

Blumenfeld, Y. J., Baer, R. J., Druzin, M. L., El-Sayed, Y. Y., Lyell, D. J., Faucett, A. M., . . . Jelliffe-Pawlowski, L. L. (2014). Association between maternal characteristics, abnormal serum aneuploidy analytes, and placental abruption. *American Journal of Obstetrics and Gynecology, 211,* 144.e1–144.e9. https://doi.org/10.1016/j.ajog.2014.03.027

Buckles, K. S., & Munnich, E. L. (2012). Birth spacing and sibling outcomes. *Journal of Human Resources, 47,* 613–642.

Bujold, E., & Gauthier, R. J. (2010). Risk of uterine rupture associated with an interdelivery interval between 18 and 24 months. *Obstetrics & Gynecology, 115,* 1003–1006.

Choi, Y., Bishai, D., & Minkovitz, C. S. (2009). Multiple births are a risk factor for postpartum maternal depressive symptoms. *Pediatrics, 123,* 1147–1154.

Conde-Agudelo, A., Belizán, J. M., Norton, M. H., & Rosas-Bermúdez, A. (2005). Effect of the interpregnancy interval on perinatal outcomes in Latin America. *Obstetrics & Gynecology, 106,* 359–366.

Conde-Agudelo, A., Rosas-Bermudez, A., Castaño, F., & Norton, M. H. (2012). Effects of birth spacing on maternal, perinatal, infant, and child health: A systematic review of causal mechanisms. *Studies in Family Planning, 43,* 93–114.

Conde-Agudelo, A., Rosas-Bermúdez, A., & Kafury-Goeta, A. C. (2006). Birth spacing and risk of adverse perinatal outcomes: A meta-analysis. *JAMA, 295,* 1809–1823.

Conde-Agudelo, A., Rosas-Bermúdez, A., & Kafury-Goeta, A. C. (2007). Effects of birth spacing on maternal health: A systematic review. *American Journal of Obstetrics and Gynecology, 196,* 297–308.

Davis, E. M., Babineau, D. C., Wang, X., Zyzanski, S., Abrams, B., Bodnar, L. M., & Horwitz, R. I. (2014). Short inter-pregnancy intervals, parity, excessive pregnancy weight gain and risk of maternal obesity. *Maternal and Child Health Journal, 18,* 554–562.

Falnes-Dalheim, A. (2009). *Dokumentasjon av registerbasert familie- og husholdningsstatistikk—Årlig statistikk f.o.m. 2005, basert på folkeregistrert adresse per 1. Januar* [Documentation of register-based family and household statistics—Annual statistics from 2005, based on registered address as of 1 January] (Report No. 2009/54). Statistics Norway. Retrieved from https://www.ssb.no/befolkning/artikler-og-publikasjoner/dokumentasjon-av-registerbasert-familie-og-husholdningsstatistikk

Gemmill, A., & Lindberg, L. D. (2013). Short interpregnancy intervals in the United States. *Obstetrics & Gynecology, 122,* 64–71.

Glazebrook, C., Sheard, C., Cox, S., Oates, M., & Ndukwe, G. (2004). Parenting stress in first-time mothers of twins and triplets conceived after in vitro fertilization. *Fertility and Sterility, 81,* 505–511.

Grundy, E., & Kravdal, Ø. (2014). Do short birth intervals have long-term implications for parental health? Results from analyses of complete cohort Norwegian register data. *Journal of Epidemiology & Community Health, 68,* 958–964.

Grundy, E., & Tomassini, C. (2005). Fertility history and health in later life: A record linkage study in England and Wales. *Social Science & Medicine, 61,* 217–228.

Hagen, E. W., Mirer, A. G., Palta, M., & Peppard, P. E. (2013). The sleep-time cost of parenting: Sleep duration and sleepiness among employed parents in the Wisconsin Sleep Cohort Study. *American Journal of Epidemiology, 177,* 394–401.

Hanley, G. E., Hutcheon, J. A., Kinniburgh, B. A., & Lee, L. (2017). Interpregnancy interval and adverse pregnancy outcomes. *Obstetrics & Gynecology, 129,* 408–415.

Hanson, H. A., Smith, K. R., & Zimmer, Z. (2015). Reproductive history and later-life comorbidity trajectories: A Medicare-linked cohort study from the Utah Population Database. *Demography, 52,* 2021–2049.

Khan, K. S., Chien, P. F. W., & Khan, N. B. (1998). Nutritional stress of reproduction: A cohort study over two consecutive pregnancies. *Acta Obstetricia et Gynecologica Scandinavica, 77,* 395–401.

King, J. C. (2003). The risk of maternal nutritional depletion and poor outcomes increases in early or closely spaced pregnancies. *Journal of Nutrition, 133,* 1732S–1736S. https://doi.org/10.1093/jn/133.5.1732S

Kitterød, R. H., & Lappegård, T. (2012). A typology of work-family arrangements among dual-earner couples in Norway. *Family Relations, 61,* 671–685.

Kravdal, Ø. (2020). Are sibling models a suitable tool in analyses of how reproductive factors affect child mortality? *Demographic Research, 42,* 777–798. https://doi.org/10.4054/DemRes.2020.42.28

Kravdal, Ø., Tverdal, A., & Grundy, E. (2020). The association between parity, CVD mortality and CVD risk factors among Norwegian women and men. *European Journal of Public Health, 30,* 1133–1139.

Liu, C., Snowden, J. M., Lyell, D. J., Wall-Wieler, E., Abrams, B., Kan, P., . . . Carmichael, S. L. (2021). Interpregnancy interval and subsequent severe maternal morbidity: A 16-year population-based study from California. *American Journal of Epidemiology, 190,* 1034–1046.

Männistö, T., Mendola, P., Kiely, M., O'Loughlin, J., Werder, E., Chen, Z., . . . Grantz, K. L. (2016). Maternal psychiatric disorders and risk of preterm birth. *Annals of Epidemiology, 26,* 14–20.

Margolis, R., & Myrskylä, M. (2015). Parental well-being surrounding first birth as a determinant of further parity progression. *Demography, 52,* 1147–1166.

Miller, G., & Babiarz, K. S. (2016). Family planning program effects: Evidence from Microdata. *Population and Development Review, 42,* 7–26.

Miranda, V. (2020). Recent trends in birth intervals in Sweden: A decline of the speed–premium effect? *European Journal of Population, 36,* 499–510.

Molitoris, J., Barclay, K., & Kolk, M. (2019). When and where birth spacing matters for child survival: An international comparison using the DHS. *Demography, 56,* 1349–1370.

Ngo, A. D., Roberts, C. L., & Figtree, G. (2016). Association between interpregnancy interval and future risk of maternal cardiovascular disease—A population-based record linkage study. *BJOG: An International Journal of Obstetrics and Gynaecology, 123,* 1311–1318.

Nomaguchi, K. M., & Bianchi, S. M. (2004). Exercise time: Gender differences in the effects of marriage, parenthood, and employment. *Journal of Marriage and Family, 66,* 413–430.

Poehlmann, J., Schwichtenberg, A. M., Bolt, D., & Dilworth-Bart, J. (2009). Predictors of depressive symptom trajectories in mothers of preterm or low birth weight infants. *Journal of Family Psychology, 23,* 690–704.

Read, S., Grundy, E., & Wolf, D. A. (2011). Fertility history, health, and health changes in later life: A panel study of British women and men born 1923–49. *Population Studies, 65,* 201–215.

Reczek, C., Thomeer, M. B., Lodge, A. C., Umberson, D., & Underhill, M. (2014). Diet and exercise in parenthood: A social control perspective. *Journal of Marriage and Family, 76,* 1047–1062.

Rutstein, S. O. (2005). Effects of preceding birth intervals on neonatal, infant and under-five years mortality and nutritional status in developing countries: Evidence from the Demographic and Health Surveys. *International Journal of Gynecology & Obstetrics, 89*(Suppl. 1), S7–S24.

Sandström, A., Cnattingius, S., Wikström, A. K., & Stephansson, O. (2012). Labour dystocia—risk of recurrence and instrumental delivery in following labour—A population-based cohort study. *BJOG: An International Journal of Obstetrics and Gynaecology, 119,* 1648–1656.

Sayer, L. C. (2005). Gender, time and inequality: Trends in women's and men's paid work, unpaid work and free time. *Social Forces, 84,* 285–303.

Sjölander, A., Frisell, T., Kuja-Halkola, R., Öberg, S., & Zetterqvist, J. (2016). Carryover effects in sibling comparison designs. *Epidemiology, 27,* 852–858.

Staneva, A., Bogossian, F., Pritchard, M., & Wittkowski, A. (2015). The effects of maternal depression, anxiety, and perceived stress during pregnancy on preterm birth: A systematic review. *Women and Birth, 28,* 179–193.

Thagard, A. S., Napolitano, P. G., & Bryant, A. S. (2018). The role of extremes in interpregnancy interval in women at increased risk for adverse obstetric outcomes due to health disparities: A literature review. *Current Women's Health Reviews, 14,* 242–250.

Thorpe, K., Golding, J., MacGillivray, I., & Greenwood, R. (1991). Comparison of prevalence of depression in mothers of twins and mothers of singletons. *BMJ, 302,* 875–878.

Umberson, D., Liu, H., Mirowsky, J., & Reczek, C. (2011). Parenthood and trajectories of change in body weight over the life course. *Social Science & Medicine, 73,* 1323–1331.

Weisband, Y. L., Manor, O., Friedlander, Y., Hochner, H., Paltiel, O., & Calderon-Margalit, R. (2020). Interpregnancy and interbirth intervals and all-cause, cardiovascular-related and cancer-related maternal mortality: Findings from a large population-based cohort study. *Journal of Epidemiology & Community Health, 74,* 957–963.

Wendt, A., Gibbs, C. M., Peters, S., & Hogue, C. J. (2012). Impact of increasing inter-pregnancy interval on maternal and infant health. *Paediatric and Perinatal Epidemiology, 26*(Suppl. 1), 239–258.

Wenze, S. J., Battle, C. L., & Tezanos, K. M. (2015). Raising multiples: Mental health of mothers and fathers in early parenthood. *Archives of Women's Mental Health, 18,* 163–176.

Winkvist, A., Rasmussen, K. M., & Habicht, J. P. (1992). A new definition of maternal depletion syndrome. *American Journal of Public Health, 82,* 691–694.

World Health Organization. (2007). *Report of a WHO technical consultation on birth spacing: Geneva, Switzerland 13–15 June 2005*. World Health Organization. Retrieved from https://www.who.int/publications/i/item/WHO-RHR-07.1

Yeakey, M. P., Muntifering, C. J., Ramachandran, D. V., Myint, Y., Creanga, A. A., & Tsui, A. O. (2009). How contraceptive use affects birth intervals: Results of a literature review. *Studies in Family Planning, 40,* 205–214.

Zhu, B.-P., Grigorescu, V., Le, T., Lin, M., Copeland, G., Barone, M., & Turabelidze, G. (2006). Labor dystocia and its association with interpregnancy interval. *American Journal of Obstetrics and Gynecology, 195,* 121–128.

Zhu, B.-P., Rolfs, R. T., Nangle, B. E., & Horan, J. M. (1999). Effect of the interval between pregnancies on perinatal outcomes. *New England Journal of Medicine, 340,* 589–594.

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