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Unique influences of pregnancy and anticipated parenting on cigarette smoking: results and implications of a within-person, between-pregnancy study

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Abstract

Not all pregnant individuals want to become parents and "parenting intention" can also vary within individuals during different pregnancies. Nevertheless, the potential impact of parenting intention on health-related behavior during pregnancy has been heavily underexplored. In this study, we employed a within-person between pregnancy design to estimate the effect of parenting-specific influences on smoking, separate from pregnancy-specific and individual-level influences. We quantified within-mother differences in smoking during pregnancies of infants they reared ($n = 84$) versus pregnancies of infants they placed for adoption at birth ($n = 65$) using multivariate mixed-effects Poisson regression models. Mean cigarettes/day declined as the pregnancy progressed regardless of whether infants were reared or placed. However, participants smoked fewer

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Ethics approval After ethical review of the protocol, this study was determined to be exempt from Institutional Review Board review at Brigham and Women's Hospital due to its exclusive use of secondary analysis of existing data that were and remained de-identified.

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cigarettes/day during reared pregnancies. Relative to "adopted" pregnancies, smoking during "reared" pregnancies was lower by 24%, 41%, and 54% in first (95% CI 0.64–0.90; $p = 0.001$), second (95% CI 0.48–0.72; $p < 0.001$), and third trimesters (95% CI 0.36–0.59; $p < 0.001$), respectively, independent of between-pregnancy differences in maternal age, fetal sex, parity, and pregnancy complications. Female sex and nulliparity were protective. Parenting intention was associated with a protective effect on pregnancy smoking independent of pregnancy-specific influences and individual characteristics. Failure to consider the impact of parenting intention on health-related behavior during pregnancy could perpetuate an unrealistic expectation to "*do what's best for the baby*" and stigmatize women with unintended or unwanted pregnancies.

Keywords

Pregnancy smoking; Tobacco; Nicotine; Protective factors; Substance use

Introduction

The conventional focus on how maternal smoking influences pregnancy has overshadowed the notable protective effect of pregnancy on maternal smoking (Massey et al. 2017; 2022a). Positive changes in tobacco and other drug use made by pregnant individuals – in the absence of intervention—rival the effects of the best available interventions (Edwards et al. 2019; Kendler et al. 2017; Solomon and Quinn 2004). As such, pregnancy's protective effect on substance use may be viewed as a natural paradigm for understanding how substance related processes are interrupted (Massey et al. 2018a, b; 2017). Despite this, there is surprisingly little research on exactly what facilitates pregnancy's protective effect, an effect widely attributed to "maternal motivation" to protect their children (Kendler et al. 2017). While there is some evidence to support this assumption (O'Campo et al. 1992; Massey et al. 2012; 2022a), other mechanisms are plausible. For example, reduction in smoking frequency observed between conception and recognition of the pregnancy supports the possibility of a biological mechanism of pregnancy's protective effect (Massey et al. 2022b). In this study, we examined another possible mechanism by considering how developmental influences related to becoming a parent may impact the effect of being pregnant on smoking behavior.

Social role transitions during adulthood, particularly transitions into family roles, are strongly associated with positive changes in substance use (Graham et al. 2006; Schoenaker et al. 2017). The decision to become a parent for the first time, or to an additional child, may come with an expectation of sacrificing personal gratification in favor of long-term goals. This could explain why pregnant smokers who successfully quit are more likely to be married, have higher educational attainment, and report changing health related behavior because of the pregnancy, when compared to pregnant smokers who do not quit (Massey et al. 2016; Solomon and Quinn 2004). Yet the potential impact of an individual's intention, readiness, and/or desire to have a child on smoking and other health related behavior is unclear and underrecognized. This is troubling when we consider that not all pregnant individuals want to become parents.

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Up to half of pregnancies in the USA are unintended and one in five are unwanted (Bearak et al. 2020). Viewed in this context, urging women to "do what's best for the baby" by changing health related behavior, including but not limited to smoking, not only presumes a capacity or desire for parental sacrifice that may or may not be present but emphasizes the experience of the fetus over that of the pregnant individual. Worse yet, prioritizing fetal well-being in this way could inadvertently shame women who exhibit less than ideal health practices and discourage them from seeking timely prenatal care (Harris 2000). For these reasons, we considered how variability in parenting intention could modify the effect of pregnancy on smoking behavior. This is not to insinuate that individuals with unintended or unwanted pregnancies care less about their infants than those who intended to conceive. Rather, the autonomy and personhood of pregnant individuals is easily obscured in the prenatal care setting, and even more so when reproductive rights are limited, making the impact of parenting intention on maternal behavior during pregnancy a particularly timely issue.

Influences on smoking during pregnancy may be pregnancy-specific (i.e., biological) or parenting-specific related to the intention, desire, or preparation to become a parent (e.g., preparing to provide a smoke-free home, wanting to be a good role model; Curry et al. 2001). Determining the extent to which changes in smoking behavior are attributable to pregnancy-specific versus parenting-specific influences, however, presents some methodologic challenges as it is difficult to separate becoming pregnant from becoming a parent. Moreover, many individual and psychosocial factors influence smoking behavior, independent of the pregnancy. To overcome these methodological challenges, we examined a unique sample of smokers who reported on their smoking during multiple pregnancies discordant parenting outcome; they placed their infants for adoption after one pregnancy, the adopted pregnancy, but not after other(s), referred to as the reared pregnancies. This enabled us to estimate the unique impact of parenting-specific influences, or simply, *parenting intention*, on smoking behavior. This design further allowed smokers to act as their own controls for sociodemographic characteristics known to influence smoking (Massey et al. 2011, 2012). We expected to find unique protective effects associated with (1) parenting-specific influences, as evidenced by lower mean cigarettes/day smoked during reared pregnancies, as well as with (2) pregnancy-specific influences, as evidenced by decreasing mean cigarettes/day smoked across trimesters of both adopted and reared pregnancies.

Materials and methods

Participants

Derivation of the analytic sample from original studies is shown in Fig. 1. Briefly, participants were birth mothers enrolled in a parent–offspring adoption study who subsequently enrolled in a related sibling comparison study involving one more of their biological children whom they did not place for adoption. The analytic sample included 65 women for whom complete data on pregnancy smoking were available for a child whom they placed for adoption, referred to as the "adopted pregnancy" (Leve et al. 2019) and one or more children whom they did not place for adoption and became parents to, referred to as

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"reared pregnancies" (Natsuaki et al. 2019), and who reported smoking during at least one these pregnancies.

In the full sample of biological mothers from which the analytic sample of pregnancy are derived, mean age at delivery of the adopted pregnancy was 22.9 years (*SD* = 4.7); median educational attainment was a high school degree. Racial and ethnic distribution were: 70.1% non-Hispanic White, 13.4% non-Hispanic Black, 6.1% Hispanic, 9.1% identified with more than one race or ethnicity, unknown race or ethnicity, or did not identify. Relationship status was: 77.9% single, 6.1% married; 14.6% divorced or widowed, not remarried; 1.4% unknown or not reported. Women in the analytic sample of pregnancy smokers were more likely to identify as non-Hispanic White (85% versus 70%, $p = 0.07$) and less educated, with 37% vs. 26% achieving less than a high school diploma ($p = 0.01$). Institutional review board approval and informed consent procedures were completed prior to the conduct of original studies as well as the current secondary analysis of existing data from these studies.

Measures

Pregnancy smoking—Smoking was assessed between 3- and 6-month postpartum after the adopted pregnancy and a mean of 6.9 years (SD = 1.9) after reared pregnancies using the Pregnancy History Calendar (PHC) which was developed for this study based on the Life History Calendar method for retrospective recall of substance use (Caspi et al. 1996). In the PHC, the interviewer began by helping each participant create a timeline of memorable events and their dates during the past year and record them onto a calendar. Dates of conception, each trimester of pregnancy, and delivery were then entered. Next, the interviewer asked participants to refer to the calendar when asked about any smoking as well as when asked about the mean cigarettes per day smoked during each trimester of the pregnancy. Computer-assisted personal interviewing was employed during administration of the PHC as a means of reducing social desirability bias in reporting of stigmatizing information (Duffy and Waterton 1984; Hester and Miller 2006; Newman et al. 2002).

Reared vs. adopted pregnancy as a proxy for parenting intention—We used a dummy variable to reflect the relative presence versus absence of parenting intention, based on whether the pregnancy resulted in adoption (intention presumed to be absent = 0) or in child-rearing (intention presumed to be present = 1).

Covariates—Statistical models were adjusted for fetal sex, maternal age at delivery, nulliparity, and a pregnancy complications score derived from the Perinatal Risk Index previously described (Marceau et al. 2016). Briefly, we used an ordinal score ranging from 1 to 6 derived from ratings on a range of individual pregnancy complication risk factors related to individual maternal, fetal, and placental characteristics.

Statistical analyses

We first examined descriptive characteristics of reared versus adopted pregnancies. Next, we used three separate mixed-effects Poisson regression models to estimate the effect of parenting intention on smoking in each trimester of pregnancy expressed as an adjusted rate ratio (RR) of mean cigarettes/day smoked during reared versus adopted pregnancies.

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This approach enabled the estimation of both between- and within-group effects, while accounting for non-independence of repeated measures of smoking by participants using a random intercept for each participant (Diggle et al. 2002). Third, we examined the association between parenting intention and change in smoking by including a random intercept for each participant in a longitudinal model that assessed change across trimesters. All models were adjusted for fetal sex, maternal age at delivery, nulliparity, and pregnancy complications. Statistical analysis was performed using R version 4.1 (lme4 package, v1.1–26; Bates et al. 2015). Statistical significance was set, a priori, at $p < 0.05$, for two-sided tests.

Results

Descriptive characteristics

Sixty-one percent of women ($n = 40$) smoked in each of their pregnancies. Just under a third (28%, $n = 18$) smoked during adopted but not reared pregnancies, and 11% ($n = 7$) smoked during the reared but not adopted pregnancy. Characteristics of reared versus adopted pregnancies and between-group differences in these characteristics are shown in Table 1. Participants were younger, more likely to be pregnant for the first time, and more likely to have smoked (89% versus 68%) during pregnancies of children placed for adoption relative to children reared. Mean cigarettes/day smoked in reared and adopted pregnancies, by trimester, (unadjusted) are illustrated in the line graph in Fig. 2.

Cross-sectional models of parenting intention and smoking

Parameter estimates from adjusted models are shown in Table 2. Relative to adopted pregnancies, women smoked at lower levels during reared pregnancies, independent of maternal age, fetal sex, nulliparity, and pregnancy complications. Specifically, women smoked 24% fewer cigarettes/day during the first trimester (95% CI 0.64–0.90; $p = 0.001$); 41% fewer cigarettes/day during the second trimester (95% CI 0.48–0.72; $p < 0.001$); and 54% fewer cigarettes/day during the third trimester (95% CI 0.36–0.59; $p < 0.001$) during their reared pregnancies compared to their adopted pregnancy. Female fetal sex was independently associated with lower smoking levels in the second ($aRR_{T2} = 0.74$, 95% CI 0.59–0.72, $p = 0.01$) and third trimesters ($aRR_{T3} = 0.70$, 95% CI 0.53–0.91, $p = 0.007$). Nulliparity was also independently associated with lower levels of smoking across all trimesters ($aRR_{T1} = 0.79$, 95% CI 0.64–0.97, $p = 0.03$; $aRR_{T2} = 0.60$, 95% CI 0.45–0.79, $p < 0.001$; $aRR_{T3} = 0.60$, 95% CI 0.43–0.84, $p = 0.004$).

Longitudinal model of parenting intention and change in smoking

Results from the longitudinal Poisson mixed-effects model of the association between parenting influences and change in smoking are shown in Table 3. Nulliparity ($aRR_{\text{nulliparity}} = 0.68$; 95% CI 0.58–0.79, $p < 0.001$) and female fetus ($aRR_{\text{female}} = 0.81$; 95% CI 0.72–0.92, $p = 0.001$) were each independently associated with lower mean cigarettes/day. Adjusting for covariates, smoking levels decreased across trimesters of both the reared and adopted pregnancies. With first trimester smoking as the reference, mean cigarettes/day was 23% lower in the second trimester (95% CI 0.66–0.88, $p < 0.001$) and 34% lower in the third trimester (95% CI 0.57–0.76, $p < 0.001$), independent of between-pregnancy differences in

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maternal age, fetal sex, nulliparity, and pregnancy complications. These between-trimester changes in smoking did not differ between adopted pregnancies (reference) and reared pregnancies.

Discussion

Positive changes in smoking made by pregnant individuals could reflect protective influences specific to pregnancy, intended parenting, or some combination. Results from this unique within-individual, between-pregnancy study support a unique protective effect of parenting intention on smoking. Mean cigarettes/day smoked was 24%, 41%, and 54% less during the first, second, and third trimesters of pregnancies of infants reared compared to those of infants placed for adoption (Table 2). This “effect” of parenting intention on smoking was consistent even` after adjusting for between-pregnancy differences in maternal age and parity, factors previously linked to between-person differences in pregnancy smoking (Cnattingius 2004; Schneider et al. 2010; Riaz et al. 2018). For example, a greater percentage of adopted pregnancies were first-time pregnancies (Table 1) a known protective factor in pregnancy smoking (Solomon and Quinn 2004). Nevertheless, even after controlling for nulliparity, smoking frequency was still greater in adopted pregnancies (Table 3).

Our results also support a protective effect of being pregnant on smoking behavior, regardless of parenting intention. As illustrated in Fig. 2, mean cigarettes smoked per day declined with each trimester in both reared and adopted pregnancies and did so to a remarkably similar extent (Table 3). However, while being pregnant and becoming a parent often (but not always) overlap temporally during pregnancy, our quasi-experimental approach supports a distinction between pregnancy-specific and parenting-specific influences. Individuals smoked less when they intended to become parents. This distinction has some important ramifications for prevention and public policy. For example, the widely perpetuated view of pregnancy as a “window of opportunity” for intervention on smoking and other health related behaviors (Chisolm and Coleman-Cowger 2011; DiClemente et al. 2000) obscures the potential impact of parenting intention, or more simply, wanting to have a baby, on health-related behavior. This is important since many pregnant individuals do not want or intend to become a parent to a new infant. Between 2015 and 2019, an estimated 39% of pregnancies in the USA were unintended; this percentage may be expected to increase with diminishing access to reproductive care in the USA (Bearak et al. 2020). While it may be easier to assume that every pregnant individual wants to become a parent, results of this study challenge this perspective by underscoring how parenting intention often varies from pregnancy-to-pregnancy and is in fact associated with within-person differences smoking behavior.

Although this study emphasizes the effect of between-pregnancy variability in parenting intention on pregnancy smoking, we reject the notion, whether implied or perceived, that women who continue to smoke during pregnancy or choose adoption placement care less about the well-being of the fetus. The guilt and shame felt by pregnant smokers about the potential harm they might be causing to the fetus is well documented (Grant et al. 2020). Moreover, a recent study that compared empathic ability in pregnant smokers who quit and

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those who did not (as biologically verified) failed to find any between-group difference in empathic concern or perspective taking (Massey et al. 2022a). Our results are also significant in highlighting how most women who smoked during pregnancy substantially reduced the frequency at which they smoked as the pregnancy progressed regardless of whether they intended to raise the baby (Fig. 2). Overall, this study suggests that smoking behavior during pregnancy reflects not only smoking-related influences but also underlying attitudes towards the pregnancy and parenting. We recommend that providers examine internal biases that may contribute to idyllic portrayals of pregnancy and motherhood that are neither realistic nor representative of the heterogeneity of actual experiences. Ultimately, conflating pregnancy with desired parenthood invalidates the autonomy and desires of pregnant individuals, which may itself adversely impact health related behavior.

As always, findings should be interpreted within the context of the study's limitations. First, data on smoking relied on retrospective maternal reports of smoking at 3 to 6 months after delivery of the child placed for adoption, and about 7 years after delivery following reared pregnancies. Prospective reporting was impossible within the ethical constraints associated with the recruitment of women who made adoption placements and the practical aspects of a sibling comparison study (Leve et al. 2019, Natsuaki et al. 2019). Prior evidence for the accuracy of retrospective recall of substance use during pregnancy many years after delivery (Hensley Alford et al. 2009; Ramos et al. 2020), however, provided us confidence in the reliability of these data.

Next, our within-person design provided a powerful control for stable between-person differences in sociodemographic and phenotypic influences on smoking (Massey et al. 2012, 2015; Massey and Compton 2013, Massey et al. 2016). Within-person fluctuation in some of these influences from one pregnancy to the next, however, is certainly possible. While we adjusted for between-pregnancy discordance in age and parity, educational attainment or marital status may have changed between pregnancies. Examining the relationship between parenting intention and pregnancy smoking, as a function of sociodemographic change in future studies could confirm sociodemographic differences as markers of readiness and intention to parent.

We considered the possibility that the discordance in smoking between adopted and reared pregnancies reflected increased smoking to cope with unwanted pregnancy, associated stigma, or the anticipation of grief associated with adoption placement (Coleman and Garratt 2016). However, several factors argue against this possibility. First, stress related to anticipated parenting, especially for first-time parents, can be substantial (Huizink et al. 2017) and not necessarily less than stress preceding adoption placement as no prior study has compared this to our knowledge. Next, grief experienced following adoption placement is known to impact women's subsequent pregnancies (O'Leary 2004). Since most reared pregnancies in our sample occurred after the adopted pregnancies, stress may have actually been higher during reared pregnancies. Thus, we propose that although it is easy to assume that women who place their infants for adoption are under more psychological stress, preparing to become a parent is also inherently stressful. Regardless, future within-person between-pregnancy studies with repeated measures of stress would be ideal to confirm findings found herein.

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Next, we also did not directly investigate the impact of pregnancy sequence on smoking behavior. Smoking in one pregnancy resulting in a healthy delivery could result in the minimization of potential health risks in subsequent pregnancies, for example (Hoff et al. 2007; Tran et al. 2014). However, the protective effect of nulliparity on smoking found in this study is consistent with substantial prior research (Riaz et al. 2018; Schneider et al. 2010; Solomon and Quinn 2004). Finally, we did not examine reasons for adoption placement nor the timing of this decision. Rather, adoption placement (versus child rearing) was used as a proxy for the relative absence of parenting intention within the within-person between-pregnancy comparison. There are a variety of reasons women decide not to raise a child, including, but not limited to financial stress, conflicting life and educational goals, or conception that was not consensual (Edwards and Williams 2000). Given the inherent variety in reasons for adoption placement, identifying factors differentially impacting individuals' parenting intentions may have important implications for interventions targeting smoking during pregnancy.

Conclusions

Variability in parenting intention exists both between individuals who are pregnant and within individuals across different pregnancies. Results of this study indicate that this variability has important implications for maternal and child health. Specifically, our within-person between-pregnancy comparison demonstrated a protective effect of intended parenting on smoking behavior above and beyond the protective effect of pregnancy alone. Findings add to a larger body of evidence supporting the interaction of social processes with smoking and substance use (Massey et al. 2012; 2015; 2018a, b; 2022a; Pickett et al. 2009; Wakschlag et al. 2003). The importance of parenting-specific influences on pregnancy smoking also has timely implications in the context of the current public debate about reproductive rights in the USA.

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Data Availability

The data that support the findings of this study are available from the corresponding author, S.M.H., upon reasonable request.

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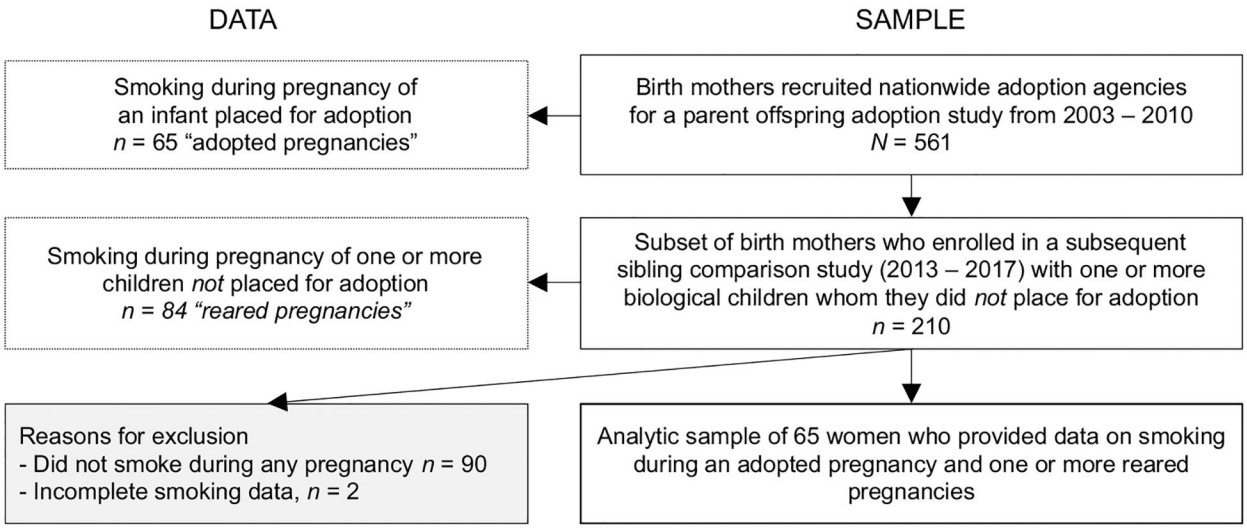

Fig. 1.

Derivation of data and sample for the within person between pregnancy design

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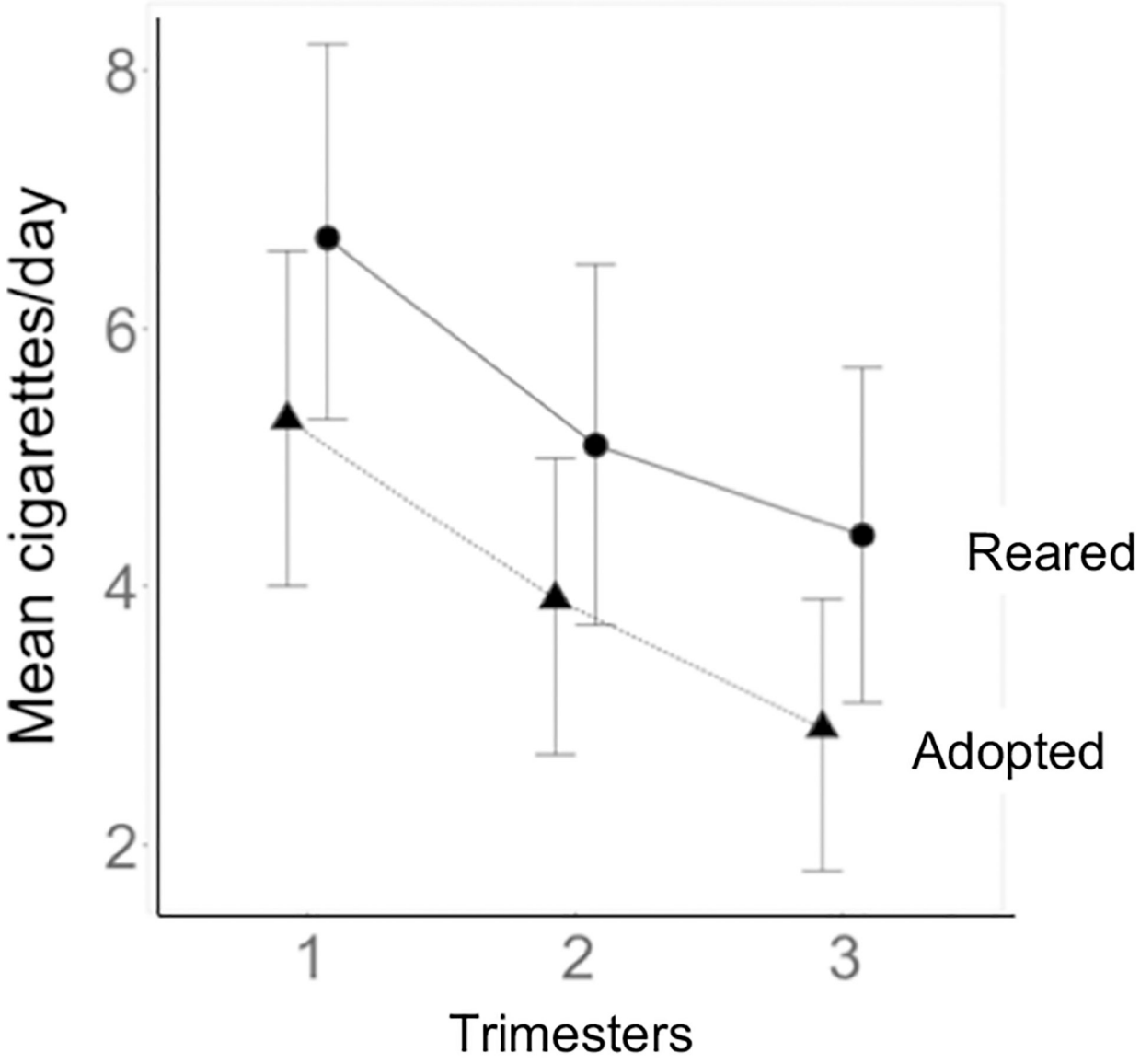

Fig. 2.

Mean cigarettes/day smoked by trimester and 95% confidence intervals in reared (n = 84) vs. adopted (n = 65) pregnancies

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Table 1

Characteristics of reared and adopted pregnancies

	Reared pregnancies (*n* = 84) Mean ± SD or *n* (%)	**Adopted pregnancies (*n* = 65)**	**Between-group difference *P***
Mean years of age at delivery	25.3 ± 4.3	22.8 ± 4.4	< 0.001
Nulliparity	13 (15.5%)	29 (44.6%)	< 0.001
Female infant	36 (42.9%)	35 (53.9%)	0.2
Pregnancy complications score	1.00 (0.93)	1.00 (0.75)	1
Any pregnancy smoking	56 (67.7%)	58 (89.2%)	0.001
Mean cigarettes/day smoked			
Entire pregnancy	4.0 ± 5.0	5.4 ± 5.0	0.08
Trimester 1	5.3 ± 6.1	6.7 ± 5.9	0.15
Trimester 2	3.8 ± 5.2	5.1 ± 5.6	0.15
Trimester 3	2.8 ± 4.7	4.4 ± 5.3	0.06

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Table 2

Differential effect of parenting intention, indexed by reared vs. adopted pregnancy, on mean cigarettes/day smoked (dependent variable) from Poisson mixed-effects models for each trimester

Fixed effects	**Trimester 1**		**Trimester 2**		**Trimester 3**	
	aRR (95% C.I.)	***P***	***aRR (95% C.I.)***	***P***	***aRR (95% C.I.)***	***P***
Reared vs. adopted pregnancy	0.76 (0.64, 0.90)	0.001	0.59 (0.48, 0.72)	< 0.001	0.46 (0.36, 0.59)	< 0.001
Maternal age at delivery	0.98 (0.94, 1.02)	0.354	1.02 (0.96, 1.07)	0.577	1.02 (0.96, 1.08)	0.551
Female fetus	0.94 (0.78, 1.13)	0.489	0.74 (0.60, 0.93)	0.010	0.70 (0.53, 0.91)	0.007
Nulliparity	0.79 (0.64, 0.97)	0.028	0.60 (0.45, 0.79)	< 0.001	0.60 (0.43, 0.84)	0.003
Pregnancy complications score	1.12 (0.96, 1.30)	0.139	0.97 (0.81, 1.18)	0.784	1.01 (0.81, 1.26)	0.906
Random variance	0.76		2.29		3.10	

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Table 3

Differential effects of parenting intention, indexed by reared vs. adopted pregnancy, and trimester (2 or 3 vs. 1) on smoking, in mean cigarettes/day (dependent variable) from multivariable Poisson mixed-effects regression

Mixed effects	Adj. rate ratio (95% C.I.)	P
Reared vs. adopted pregnancy (Trimester 1)	0.66 (0.57, 0.77)	< 0.001
Trimester 2 vs. 1	0.76 (0.66, 0.88)	< 0.001
Trimester 3 vs. 1	0.66 (0.57, 0.76)	< 0.001
Reared vs. adopted pregnancy × Trimester 2 vs. 1	0.95 (0.78, 1.17)	0.64
Reared vs. adopted pregnancy × Trimester 3 vs. 1	0.82 (0.66, 1.02)	0.07
Maternal age	1.00 (0.97, 1.03)	0.99
Female fetus	0.81 (0.72, 0.92)	0.001
Nulliparity	0.68 (0.58, 0.79)	< 0.001
Pregnancy complications score	1.06 (0.95, 1.19)	0.28
Random variance	1.365	