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Pregnancy Planning and its Association with Autism Spectrum Disorder: Findings from the Study to Explore Early Development

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Abstract

Objectives—To examine associations between pregnancy planning and autism spectrum disorder (ASD) in offspring.

Methods—The Study to Explore Early Development (SEED), a multi-site case-control study, enrolled preschool-aged children with ASD, other DDs, and from the general population (POP). Some children with DDs had ASD symptoms but did not meet the ASD case definition. We examined associations between mother's report of trying to get pregnant (pregnancy planning) and (1) ASD and (2) ASD symptomatology (ASD group, plus DD with ASD symptoms group combined) (each vs. POP group). We computed odds ratios adjusted for demographic, maternal, health, and perinatal health factors (aORs) via logistic regression. Due to differential associations by race-ethnicity, final analyses were stratified by race-ethnicity.

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Conflict of Interest All authors declare that they have no conflict of interest.

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Ethics Approval Not applicable.

Consent to Participate Not applicable.

Consent for Publication Not applicable.

Code Availability Not applicable.

Results—Pregnancy planning was reported by 66.4%, 64.8%, and 76.6% of non-Hispanic White (NHW) mothers in the ASD, ASD symptomatology, and POP groups, respectively. Among NHW mother-child pairs, pregnancy planning was inversely associated with ASD (aOR = 0.71 [95% confidence interval 0.56–0.91]) and ASD symptomatology (aOR = 0.67 [0.54–0.84]). Pregnancy planning was much less common among non-Hispanic Black mothers (28–32% depending on study group) and Hispanic mothers (49–56%) and was not associated with ASD or ASD symptomatology in these two race-ethnicity groups.

Conclusion—Pregnancy planning was inversely associated with ASD and ASD symptomatology in NHW mother-child pairs. The findings were not explained by several adverse maternal or perinatal health factors. The associations observed in NHW mother-child pairs did not extend to other race-ethnicity groups, for whom pregnancy planning was lower overall.

Keywords

Autism Spectrum Disorder; Pregnancy Planning; Pregnancy Intention; Developmental Disability; Race/ethnicity

Introduction

Between one-third and one-half of U.S. pregnancies are unintended (Finer & Zolna, 2016; Kost et al., 2021). Unintended pregnancies include both pregnancies that occur when no children or no more children are desired (unwanted) and pregnancies that occur earlier than desired (mistimed) (Santelli et al., 2003). Women who have unintended pregnancies are more likely to delay prenatal care and smoke and drink during pregnancy; they are less likely to take supplemental folic acid prior to pregnancy or breastfeed (Cheng et al., 2009; Dott et al., 2010; Dye et al., 1997; Gipson et al., 2008; Joyce et al., 2000). Additionally, unintended pregnancies, particularly the unwanted pregnancies subset, are associated with adverse birth outcomes, including preterm birth, low birth weight, small-for-gestational age, and congenital anomalies (Gipson et al., 2008; Shah et al., 2011). Unintended pregnancy is thus described as a central population reproductive health indicator (Finer & Zolna, 2016). Unplanned pregnancy (i.e., pregnancy that occurred when contraception was used or there was no desire to become pregnant and contraception was not used) is a distinct construct, not completely aligned with unintended pregnancy. Nonetheless, studies suggest pregnancy planning is strongly associated with pregnancy intention (Aiken et al., 2016; Wolgemuth et al., 2018) and thus, while pregnancy planning has been less well studied, there is likely considerable overlap in health behaviors and outcomes associated with unplanned versus unintended pregnancy.

Little is known about the relationship between either unintended or unplanned pregnancy and more distal effects, such as children’s risk for developmental disabilities (DDs); however, given reported associations between various developmental disabilities and maternal folic acid intake (Gao et al., 2016), smoking in pregnancy (Gutvirtz et al., 2019), preterm delivery (Schieve et al., 2015, 2016), small for gestational age (Schieve et al., 2015), congenital anomalies (Dawson et al., 2009; Schendel et al., 2009), and maternal complications (Cordero et al., 2019; rnoy, Becker, Weinstein-Fudim, & Ergaz,

2021), pregnancy planning and intendedness might be associated with children's long-term development.

The Study to Explore Early Development (SEED), a case-control study examining risk factors for autism spectrum disorder (ASD) provided an opportunity to assess the association between pregnancy planning and ASD, a pervasive developmental disability estimated to occur in 1 in 36 children (Maenner et al., 2023). ASD poses significant communication, social, and behavioral challenges and often co-occurs with other disabilities, such as intellectual disability and attention deficit hyperactivity disorder (ADHD) (Hus & Segal, 2021; Wiggins et al., 2015a). While genetic factors are implicated in the etiology of ASD (Miles, 2011) the composite evidence supports gene–environment interactions (Y. S. Kim & Leventhal, 2015). Reported risk factors for ASD are similar to those for other developmental disabilities, including maternal-fetal health conditions, such as diabetes, preeclampsia, and preterm birth, and maternal exposures such as medication use, smoking, and folic acid deficiency before and during pregnancy (Ornoy et al., 2016). Neurobiological studies suggest that embryogenesis is a critical period for ASD exposures (Arndt et al., 2005). Thus, pregnancy planning could feasibly be associated with a reduction in ASD risk through possible downstream effects on maternal health and reduction in harmful exposures just before or during pregnancy.

Methods

Study Population

SEED was conducted in six sites located in California, Colorado, Georgia, Maryland, North Carolina, and Pennsylvania. Data for this analysis were from SEED phases 1 and 2, which included children aged 24–68 months who were born in 2003–2006 and 2008–2011, respectively. Three groups of children and their mothers were enrolled in SEED: children with ASD, children with other DDs, and general population controls (POP). ASD and DD group children were identified from clinical and educational sources; POP group children were randomly sampled from birth records. The respondent for SEED interviews and self-administered forms was the biological mother (SEED 1 + 2) or another knowledgeable caregiver (SEED 1 only, ~ 2% of respondents). Because this study used reproductive health data, which was only collected if the biological mother was the respondent, we excluded the small percentage of children with other caregiver respondents.

SEED was conducted in accordance with prevailing ethical principles. Institutional Review Boards at CDC and each study site approved the SEED protocol. Informed consent was obtained from all participants.

Data Collection

Mothers completed self-administered forms on their health and their child's health and development and participated in telephone interviews that included questions on their reproductive history, pregnancy with the index child, and family socio-demographics. Children underwent in-person developmental assessments. We also abstracted maternal prenatal and labor and delivery medical records and obtained limited birth certificate

variables for each child. Additional information on SEED methods is published elsewhere (Schendel et al., 2012).

SEED Case-Control Determination

At enrollment, mothers of all children were administered the Social Communication Questionnaire (SCQ) to screen for ASD symptomatology. Children were designated as *potential* ASD cases if they had a previous ASD diagnosis or autism special education classification and/or had a positive SCQ screen (regardless of ASD diagnosis). During their developmental assessment, children designated as potential ASD cases were administered the Autism Diagnostic Observation Schedule (ADOS). Their mothers were administered the Autism Diagnostic Interview - Revised (ADI-R). Final ASD case classification was based on a SEED-derived algorithm of ADOS and ADI-R scores (Wiggins et al., 2015a, b). Children not designated potential ASD cases at enrollment and children designated potential ASD cases who did not meet study criteria for ASD, received a final classification of DD or POP, depending on their original sample source (clinic/education source or random birth certificate sample). The DD group was further subdivided into those with versus without ASD symptoms; children with ASD symptoms were those who had either a positive SCQ screen or a previous ASD diagnosis/education classification but did not meet SEED ASD criteria based on the ADOS and ADI-R.

Because previous SEED analyses found that children with DD and ASD symptoms were phenotypically similar to children meeting SEED criteria for ASD case classification, for some analyses, we combined children with ASD and children with DD with ASD symptoms (collectively referred to here as “ASD symptomatology”) (Wiggins et al., 2015a, b). We thus examined two outcomes in this study: ASD and ASD symptomatology. The ASD outcome included only children who met SEED ASD case criteria. The ASD symptomatology outcome included both children who met the ASD case criteria and children who met the DD with ASD symptoms criteria. We did not assess children in the DD group who did not have ASD symptoms; this group was a heterogeneous mix of disabilities that could not be further sub-divided.

Assessment of Pregnancy Planning

The SEED maternal interview included the question: “Before getting pregnant with (CHILD), were you trying to get pregnant?” Mothers who responded affirmatively were considered to have planned their pregnancy.

Covariates

Covariates included demographic and pregnancy/perinatal health factors. Demographic factors were maternal race-ethnicity, age, education, and parity at time of child’s birth, household income, and child sex. Pregnancy and perinatal health factors were maternal tobacco smoking, binge drinking, and cannabis use ≤ 3 months before or during pregnancy, pre-pregnancy body mass index (BMI), gestational weight gain, hypertension during pregnancy, gestational diabetes, preterm delivery (< 37 weeks gestational age), and multiple birth. Pregnancy complications and outcomes examined here were previously reported to be associated with ASD (Cordero et al., 2019; Ornoy et al., 2021; Schieve et al., 2015, 2016)

and either pregnancy intendedness or health behaviors that could potentially be modified prior to pregnancy (Daly et al., 2022; Gipson et al., 2008; Seely & Ecker, 2011; Shah et al., 2011). Hypertension during pregnancy included both pregnancy-induced and pre-existing hypertension because women with pre-existing hypertension that is not well managed early in pregnancy are at increased risk for development of preeclampsia and eclampsia (Seely & Ecker, 2011). We examined multiple birth as a potential confounder because in the first phase of SEED, multiple births with ASD were oversampled; thus, by design, our ASD sample disproportionately included multiple births relative to the POP sample. Because multiple births may result from infertility treatments (a specific type of planned pregnancy), this could have introduced confounding (Schieve, 2007).

Data for most demographics and health behaviors were self-reported during maternal interviews. Gestational age and parity were obtained from birth certificates. Gestational diabetes, hypertension, pre-pregnancy BMI, and gestational weight gain were defined using previously-described algorithms (Cordero et al., 2019; Windham et al., 2019) using data from maternal interviews, self-administered health forms, and medical record abstractions. Pre-pregnancy BMI and gestational weight gain were categorized using existing standards (IOM, 2009).

Sample Selection

We limited this analysis to participants with a maternal age ≥ 20 years and maternal education ≥ high school at the time of their child's birth. Mothers younger than 20 years or with < high school education were excluded because small sample sizes precluded separate examination of these subgroups. Given established strong negative associations between pregnancy planning and teen birth and low education attainment, we opted not to combine these small yet distinct categories with the maternal age 20–29 years and maternal education high school categories; doing so might have increased residual confounding.

Of the 5993 mother-child pairs who met our sample criteria, we excluded those for whom child's case status was not available because of missing, incomplete, or indeterminant data on developmental assessments (N = 650), and for whom data were missing for pregnancy planning (N = 424), or covariates (N = 371). In comparison to the final sample, participants excluded because of missing data were younger, less likely to be NHW, and less likely to have completed 16 or more years of school (data not shown).

Statistical Analysis

We used logistic regression to calculate unadjusted and adjusted odds ratios (OR) and 95% confidence intervals (CI) for associations between pregnancy planning and each outcome -- ASD and ASD symptomatology. The POP group served as the reference. We conducted stratified analyses to examine whether findings were consistent across demographic subgroups. These analyses indicated differential associations by race-ethnicity. We thus conducted separate analyses for non-Hispanic White (NHW), non-Hispanic Black (NHB), and Hispanic mother-child pairs. Small sample sizes precluded stratum-specific analyses for Asian/Pacific Islander and multiracial groups. (Nonetheless, participants in these two race-ethnicity groups were included in analyses for the total sample.)

For each outcome, two adjustment models were constructed. The first included maternal age, education, parity, household income, and child sex. The second included all model 1 factors plus maternal pregnancy and perinatal health factors: maternal smoking, binge drinking and cannabis use just before or during pregnancy, pre-pregnancy BMI, gestational weight gain, hypertension during pregnancy, gestational diabetes, preterm delivery, and multiple birth.

Finally, in addition to adjustment, we examined several potentially modifiable maternal health factors -- tobacco smoking, cannabis use, and binge drinking just before or during pregnancy, maternal BMI prior to pregnancy, and maternal gestational weight gain -- according to whether or not the mother reported pregnancy planning. This analysis series was limited to NHW and NHB mothers in the POP control group because the aim was to inform how pregnancy planning might be related to maternal health behaviors in the general population. We calculated prevalence ratios for associations between not planning pregnancy and each behavioral/lifestyle factor. For the NHW POP sample we derived prevalence ratios adjusted for demographic factors using modified Poisson regression. Small sample sizes precluded assessments of Hispanic and other-race-ethnicity groups and adjustment of prevalence ratios for NHB mothers.

Results

Our sample included 1252 children who met the SEED case definition for ASD, 1700 with children with ASD symptomatology more broadly defined, and 1675 POP group children (Table 1). Children with ASD or ASD symptomatology were more likely to be male and less likely to have been singleton or born at term than POP group children. Children with ASD were also more likely to have been first births. Mothers of children in both ASD groups were younger, less likely to be NHW and had lower education attainment and lower household income than POP group mothers. Mothers in the ASD groups were also more likely than POP group mothers to have hypertension during pregnancy, gestational diabetes, and to have smoked before or during pregnancy; they were less likely to have had a pre-pregnancy BMI and gestational weight gain within recommended ranges.

Overall, 67.2% of POP group mothers reported they had been trying to get pregnant with their child, and mothers of children with ASD and ASD symptomatology were significantly less likely to report pregnancy planning (57.6% and 54.4%, respectively) (Fig. 1). The pattern of results among NHW mother-child pairs was consistent with that for the total sample, but the proportions of mothers who reported pregnancy planning was higher (76.6%, 66.4%, and 64.8% for POP, ASD, and ASD symptomatology groups, respectively). Much lower proportions of NHB mothers reported pregnancy planning with no significant differences by study group (28–32%). Likewise, there were no significant differences in pregnancy planning by study group among Hispanic mothers (49–56%).

Unadjusted analyses of the total sample indicated inverse associations between pregnancy planning and ASD and ASD symptomatology (Table 2). While adjustment for demographic factors attenuated the associations, modest associations that approached statistical significance remained. Further adjustment for maternal pregnancy health factors and perinatal outcomes did not additionally impact the findings.

Among NHW mother-child pairs, pregnancy planning was inversely associated with both ASD and ASD symptomatology with similar findings in unadjusted and both adjustment models. (aORs from models that included all adjustment factors were 0.71 [0.56–0.91] and 0.67 [0.54–0.84], respectively) (Table 2). Pregnancy planning was not significantly associated with ASD for either NHB or Hispanic mother-child pairs.

NHW mothers in the POP group who did not plan their pregnancies were more likely than those who planned their pregnancies to smoke, binge drink, and use cannabis just before or during pregnancy, and be underweight or obese before pregnancy (Table 3). After adjustment for demographic factors, associations with cannabis and low pre-pregnancy BMI were slightly attenuated and there was no association with pre-pregnancy obesity. Among NHB mothers, not planning pregnancy was not significantly associated with any of the potentially modifiable health factors examined; however, binge drinking sample sizes were small yielding imprecise estimates.

Discussion

While associations between pregnancy wantedness and adverse perinatal outcomes such as preterm birth have been reported (Shah et al., 2011), to our knowledge, this is among the first studies to report associations with longer-term developmental outcomes such as ASD. Nonetheless, the mechanism underlying the associations in the current study remains unclear. Our finding that pregnancy planning is inversely associated with ASD and ASD symptomatology in NHW mother-child pairs was not explained by the demographic nor maternal or perinatal health factors included in this analysis.

In contrast to our findings for NHW mother-child pairs, pregnancy planning was not associated with ASD in NHB or Hispanic mother-child pairs. The reasons for the differential associations by race-ethnicity are not clear. Consistent with previous research on unintended pregnancy (Finer & Henshaw, 2006; Finer & Zolna, 2011; Kim et al., 2016), we found NHW mothers were more likely to report planning pregnancy overall than NHB or Hispanic mothers. Socioeconomic disparities, patient perspectives, such as ambivalence towards pregnancy and contraception, and healthcare provider and system factors such as differential access to family planning services and unequal treatment from providers based on mothers' race/ethnicity have been identified as possible contributors to racial-ethnic disparities in family planning (Dehlendorf et al., 2010). While in this study we assessed several socio-demographic factors as potential confounders, SEED lacks data on maternal pre-pregnancy perspectives, healthcare access and barriers, and patient-provider relationships. Additionally, mothers participating in SEED were asked a single question about whether they had been trying to get pregnant before conceiving their child. Pregnancy planning is a complex construct and we cannot exclude the possibility that the interpretation of and response to the SEED question was partially impacted by cultural factors that varied by race-ethnicity.

We examined associations between pregnancy planning and several potentially modifiable health factors among our population-based control group to assess whether there was variability by race-ethnicity. Our findings suggest that the formulation of a decision and the associated action of trying to get pregnant may be associated with potentially modifiable

factors in NHW, but not NHB women. For example, while NHB women who reported they had not planned their pregnancy had lower rates of tobacco smoking just before or during pregnancy than NHW women who had not planned pregnancy (12.2% versus 18.1%), there was a marked difference between non-planners and planners only among NHW mothers (with non-planners being more than three times as likely to have smoked than planners (18.1% versus 5.5%). Similarly, NHW women who did not plan their pregnancy were more likely than those who planned pregnancy to binge drink or use cannabis before or during pregnancy. Conversely, there was no significant difference in cannabis use among NHB planners and non-planners and binge drinking was low in both planners and non-planners. Our findings are consistent with previous studies reporting lower rates of smoking and binge drinking in NHB than NHW women (Denny et al., 2012; Robbins et al., 2018). While one interpretation of these findings is that pregnancy planning may lead to positive health behavior changes in NHW women, it is not possible to determine temporality of these data. We cannot exclude the possibility that NHW women who had healthy lifestyles were health conscious generally, which extended to their pregnancy planning decisions. Indeed, the addition of the potentially modifiable factors to models assessing associations between pregnancy planning and ASD in NHW mother-child pairs had no impact on the findings. Moreover, while our analyses found that the pregnancy planning construct was associated with positive health behaviors and lifestyle in NHW women, we lacked data for several factors of interest, such as folic acid supplement use. Thus, these supplemental findings should be interpreted as hypothesis-generating.

Our study has many strengths, including a large sample size that allowed us to conduct thorough stratified and adjusted analyses. SEED's rigorous standardized case classification methodology allowed us to identify ASD cases even in children without a previous ASD diagnosis, and to assess the broader outcome of ASD symptomatology. Additionally, SEED's comprehensive data collection allowed for assessment of many covariates potentially associated with pregnancy planning.

These findings should also be interpreted in the context of limitations. SEED included a single pregnancy planning question, which does not completely align with intendedness measures used in previous studies of perinatal outcomes. Nonetheless, pregnancy planning percentages from our SEED sample show a similar pattern to population-based intendedness data. The proportion of mothers who reported pregnancy planning in the SEED POP sample included in this analysis was 67% overall, and 77%, 31%, and 49% among NHW, NHB and Hispanic mothers, respectively. In comparison, data from the National Survey of Family Growth indicate 55% of pregnancies in the US in 2011 were intended, with 62%, 36%, and 44% intendedness among NHW, NHB, and Hispanic women, respectively (Finer & Zolna, 2016). Despite our large sample size, we could not examine all race-ethnicity subgroups separately. We lacked data on several important lifestyle factors that might be affected by pregnancy planning such as use of folic acid supplements prior to and early in pregnancy and medication use and discontinuation prior to pregnancy. As mentioned, we also lacked contextual data on healthcare use and access and barriers. Use of self-reported data on pregnancy planning introduces the potential for recall and social desirability bias. However, these same limitations pertain to measures of pregnancy intention, which are also typically retrospectively reported after a birth has already happened, and may be even more

hampered, by measurement instability. Reported intentions and "wantedness" have been found to increase after a baby's birth (Santelli et al., 2003). Finally, SEED participants excluded because of missing data were less likely to be NHW than those included in this study; it is possible those excluded also had different rates of pregnancy planning.

Conclusion

We found that NHW women were more likely to have planned their pregnancies than NHB and Hispanic women and that pregnancy planning in the NHW group, but not other race-ethnicity groups, was associated with reduced odds of ASD and ASD symptomatology in offspring. These findings support previous studies demonstrating that ASD is associated with various risk factors present before or during pregnancy (Guinchat et al., 2012; Ornoy et al., 2016; Schieve et al., 2018; Schmidt et al., 2012; Windham et al., 2019) and thus, the periconception period is a key ASD risk window. While we cannot fully explore the specific aspects of pregnancy planning that might explain an association with ASD, we found that NHW mothers who planned pregnancies were less likely than those who didn't to have several potentially modifiable adverse health factors. The American College of Obstetricians and Gynecologists (ACOG) recommends that during healthcare encounters, providers consider opportunities to counsel nonpregnant women of reproductive age about wellness and behaviors that might improve future obstetric outcomes ("ACOG Committee Opinion No. 762: Prepregnancy Counseling," 2019). Our findings support this recommendation and suggest that pregnancy planning associations extend to longer-term child outcomes. Future studies that provide more in-depth data on associations between pregnancy planning and maternal health behaviors and healthcare utilization can help further elucidate the underlying mechanism for the associations reported here.

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Data Availability

Not applicable.

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Significance

What is Already Known on this Subject?

Almost half of all the pregnancies in the U.S. are unintended and unintended pregnancy has been associated with adverse birth outcomes.

What this Study adds?

Among non-Hispanic white mother-child pairs, pregnancy planning was inversely associated with autism spectrum disorder (ASD) and ASD symptomatology. This association was not seen for non-Hispanic Black and Hispanic mother-child pairs, for whom pregnancy planning was lower overall.

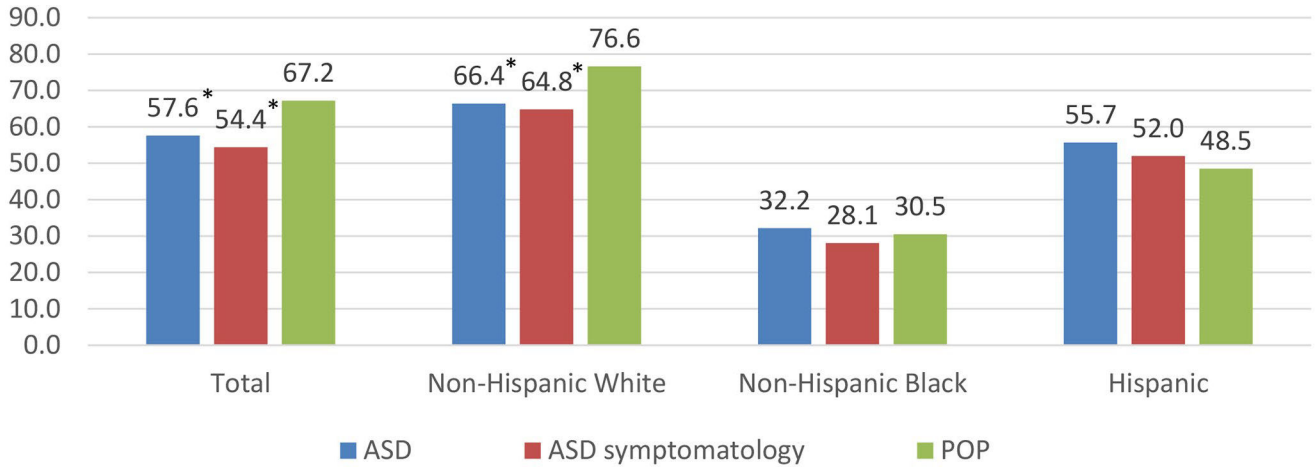

Fig. 1.

Percent of mothers who planned their pregnancy by study group and race-ethnicity in the Study to Explore Early Development. Abbreviations: ASD, autism spectrum disorder; ASD symptomatology, includes ASD and DD with autism symptoms; POP, population control group. *Indicates significant differences ($p<0.05$, based on chi-square test) between study groups (ASD vs POP and ASD symptomatology vs POP)

Table 1

Characteristics of study participants by study group in the study to explore early development

	Total (N = 4548) %	ASD (N = 1252) %	ASD Symptomatology (N = 1700) %	POP (N = 1675) %	ASD vs. POP*	ASD Symptomatology vs. POP*
Child sex male	65.0	81.6	78.5	52.3	< 0.0001	< 0.0001
Parity of index pregnancy, first born	44.8	50.0	47.1	45.6	0.0187	0.3805
Maternal race-ethnicity					< 0.0001	< 0.0001
Non-Hispanic White	62.3	53.9	52.7	70.7		
Non-Hispanic Black	17.0	21.3	23.2	11.9		
Hispanic	10.4	11.9	12.0	7.9		
Asian/Pacific Islander	6.9	9.4	8.3	6.4		
Multiracial	3.4	3.4	3.8	3.1		
Maternal age at birth (years)					0.0927	0.0005
20–29	33.2	35.1	37.7	31.3		
30–34	36.8	36.1	34.9	38.8		
35+	30.1	28.8	27.5	30.0		
Maternal education at birth (years)					< 0.0001	< 0.0001
12	11.8	12.4	15.3	8.1		
13–15	26.1	31.8	32.6	21.4		
16+	62.1	55.8	52.1	70.5		
Total household income 12 months prior to pregnancy					< 0.0001	< 0.0001
<$30,000	17.6	20.5	24.6	12.4		
$30,000–70,000	30.5	32.6	32.5	27.6		
$70,000–110,000	28.8	26.7	24.6	32.4		
≥$110,000	23.0	20.3	18.4	27.6		
Birth Plurality, Singleton	94.1	93.0	92.9	96.3	< 0.0001	< 0.0001
Preterm delivery, < 37 weeks	15.5	15.9	17.9	9.1	< 0.0001	< 0.0001
Maternal hypertension during pregnancy	16.2	19.5	19.8	12.5	< 0.0001	< 0.0001
Maternal gestational diabetes	8.0	9.6	9.4	6.6	0.0039	0.0038
Maternal tobacco smoking before or during pregnancy	12.0	15.7	16.2	9.0	< 0.0001	< 0.0001
Maternal binge drinking before or during pregnancy	9.2	9.5	9.7	9.1	0.7483	0.5724

	Total (N = 4548) %	ASD (N = 1252) %	ASD Symptomatology (N = 1700) %	POP (N = 1675) %	ASD vs. POP*	ASD Symptomatology vs. POP*
Maternal cannabis use before or during pregnancy	4.1	5.0	5.0	3.9	0.1318	0.1146
Maternal pre-pregnancy BMI (kg/m2)					< 0.0001	< 0.0001
Underweight (< 18.5)	2.9	2.5	2.9	3.0		
Normal weight (18.5–24.9)	54.2	50.6	48.1	60.1		
Overweight (25–29.9)	24.1	25.4	26.0	22.6		
Obese (≥ 30)	18.8	21.5	23.0	14.3		
IOM/ACOG recommended weight gain					0.0048	0.0007
Below	18.1	16.1	18.2	15.9		
Meets	37.8	35.1	34.4	40.9		
Exceeds	44.2	48.8	47.4	43.2		

Abbreviations: ASD, autism spectrum disorder; ASD symptomatology, includes ASD and DD with autism symptoms; POP, population control group

*p-value < 0.05 derived from chi-square test

Table 2

Associations between pregnancy planning and autism spectrum disorder and symptomatology in the study to explore early development

	Unadjusted OR (95% CI)	Adjusted Model 1 aOR[a] (95% CI)	Adjusted Model 2 aOR[a] (95% CI)
Total Sample			
ASD	0.66 (0.57–0.77)	0.90 (0.75–1.07)	0.90 (0.75–1.09)
ASD symptomatology	0.58 (0.51–0.67)	0.85 (0.72–1.01)	0.84 (0.71–1.00)
Non-Hispanic White			
ASD	0.60 (0.49–0.74)	0.71 (0.56–0.89)	0.71 (0.56–0.91)
ASD symptomatology	0.56 (0.46–0.68)	0.69 (0.56–0.85)	0.67 (0.54–0.84)
Non-Hispanic Black			
ASD	1.08 (0.73–1.61)	0.98 (0.63–1.51)	0.98 (0.62–1.56)
ASD symptomatology	0.89 (0.61–1.29)	0.88 (0.59–1.32)	0.92 (0.59–1.41)
Hispanic			
ASD	1.34 (0.84–2.14)	1.49 (0.89–2.49)	1.48 (0.83–2.63)
ASD symptomatology	1.15 (0.74–1.78)	1.45 (0.90–2.34)	1.48 (0.87–2.50)

Abbreviations: ASD, autism spectrum disorder; ASD symptomatology, includes ASD and DD with autism symptoms; POP, population control group; OR, odds ratio; aOR, adjusted odds ratio; CI, confidence interval

Model 1 includes adjustment for maternal age at birth, maternal education at birth, parity of index pregnancy, household income, and child sex

Model 2 includes all adjustment factors in model 1 + preterm delivery, multiple birth, maternal gestational diabetes, maternal hypertension during pregnancy, maternal pre-pregnancy body mass index, gestational weight gain, maternal smoking, binge drinking, and cannabis use just before or during pregnancy,

Table 3

Associations between several potentially modifiable maternal pregnancy health factors and pregnancy planning among non-hispanic white and non-hispanic black women in the POP study group in the study to explore early development

	Non-Hispanic White (N = 1184)				Non-Hispanic Black (N = 200)		
	Not trying to get pregnant (N = 277) %	Trying to get pregnant (N = 907) %	PR (95% CI)	aPR** (95% CI)	Not trying to get pregnant (N = 139) %	Trying to get pregnant (N = 61) %	PR (95% CI)
Maternal tobacco smoking before or during pregnancy	18.1	5.5	3.29 (2.27–4.75)	2.33 (1.61–3.39)	12.2	11.5	1.07 (0.47–2.44)
Maternal binge drinking before or during pregnancy	13.9	9.3	1.49 (1.04–2.13)	1.48 (1.02–2.16)	5.8	1.6	3.54 (0.45–27.66)
Maternal cannabis use before or during pregnancy							
Maternal pre-pregnancy BMI (kg/m^2)	5.4	2.0	2.73 (1.39–5.34)	1.83 (0.96–3.47)	8.6	9.8	0.88 (0.35–2.23)
Underweight (< 18.5)	5.1	2.5	2.19 (1.15–4.17)	1.88 (0.95–3.71)	2.9	1.7	1.38 (0.17–11.59)
Normal weight (18.5–24.9)	58.2	66.4	REF	REF	35.0	28.3	REF
Overweight (25–29.9)	21.3	19.8	1.16 (0.90–1.50)	1.03 (0.80–1.34)	39.4	35.0	0.96 (0.68–1.35)
Obese (≥ 30)	15.4	11.3	1.44 (1.04–1.99)	1.18 (0.85–1.64)	22.6	35.0	0.71 (0.48–1.06)
IOM/ACOG recommended weight gain							
Below	15.2	12.9	1.30 (0.96–1.76)	1.29 (0.94–1.75)	29.1	17.5	1.41 (0.82–2.45)
Meets	37.4	45.1	REF	REF	30.6	33.3	REF
Exceeds	47.4	42.0	1.16 (1.01–1.33)	1.15 (1.00–1.33)	40.3	49.1	0.95 (0.71–1.28)

Abbreviations: POP, population control group; PR, prevalence ratio; aPR, adjusted prevalence ratio; CI, confidence interval

*Total POP Sample = POP study group

**aPR: Prevalence ratios were derived from modified Poisson regression models in which the POP study group that was not trying to get pregnant was compared to the POP study group that was trying to get pregnant. All models were adjusted for maternal age at birth, maternal education at birth, parity of index pregnancy, household income, and child sex