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## Demographic Characteristics, Health Behaviors before and during Pregnancy, and Pregnancy and Birth Outcomes in Mothers with different Pregnancy Planning Status

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### Abstract

Studies on pregnancy intentions and their consequences have yielded mixed results. Here, we comprehensively analyzed the maternal characteristics, health behaviors before and during pregnancy, as well as pregnancy and birth outcomes, across three different pregnancy planning status in 861 women participating in an ongoing Asian mother-offspring cohort study. At 26-28 weeks' gestation, the women's intention and enthusiasm towards their pregnancy were used to

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**Ethical approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Informed consent** Informed consent was obtained from all individual participants included in the study.

classify their pregnancy into planned or unplanned, and unplanned pregnancy was further subdivided into mistimed or unintended. Data on maternal characteristics, health behaviors, and pregnancy outcomes up to that stage, were recorded. After delivery, birth outcomes of the offspring were recorded. Linear and logistic regression analyses were performed. Overall, 56% had a planned pregnancy, 39% mistimed, and 5% unintended. Compared to women who planned their pregnancy, women with mistimed pregnancy had higher body mass index, and were more likely to have cigarette smoke exposure and less likely to have folic acid supplementation. At 26-28 weeks' gestation, unintended pregnancy was associated with increased anxiety. Neonates of mistimed pregnancy had shorter birth length compared to those of planned pregnancy, even after adjustment for maternal baseline demographics. These findings suggest that mothers who did not plan their pregnancy had less desirable characteristics or health behaviors before and during pregnancy, and poorer pregnancy and birth outcomes. Shorter birth length in mistimed pregnancy may be attributed to maternal behaviors before or in the early stages of pregnancy, therefore highlighting the importance of preconception health promotion and screening for women of child-bearing age.

### Keywords

pregnancy; family planning; maternal health behavior; neonatal outcome

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### Introduction

Within the realms of the Developmental Origins of Health and Disease (DOHaD) hypothesis (Barker et al. 1993), a body of literature has found associations between adverse maternal environment *during* pregnancy and poor outcomes in the offspring. Intervention strategies between various gestational periods for the mothers and the first two years after birth for the offspring have been proposed as preventive measures to minimize the risk of health problems in later life (1000 days 2015). However, such prevention approach is incomplete without accounting for the contribution of *preconception* factors to pregnancy and birth outcomes (Cnattingius et al. 1998; Haas et al. 2005; Witt et al. 2012). It is possible that maternal unhealthy lifestyles *before* conception persist throughout pregnancy until delivery, or are rectified when mothers recognize that they are pregnant (Dott et al. 2010). How such phenomena modify pregnancy outcomes and future health trajectory in the offspring deserves further study.

Pregnancy planning status has previously been studied to understand women's readiness before conception and its consequences, but findings of the studies were mixed. Most studies found that mothers of planned and unplanned pregnancies differed in their demographic characteristics (Baydar 1995; Carson et al. 2011; Flower et al. 2013; Karacam et al. 2011; Rosenfeld and Everett 1996; Singh et al. 2013) and behaviors before pregnancy (Chuang et al. 2011; Dott et al. 2010; Green-Raleigh et al. 2005). However, no difference in maternal behaviors before pregnancy was observed across different pregnancy intentions in one study (Chuang et al. 2010). Unplanned pregnancy has been associated with unhealthy behaviors during pregnancy (Dott et al. 2010; Gipson et al. 2008; Najman et al. 1991) and several adverse birth outcomes including reduced birth weight, shortened birth length and

prematurity (Flower et al. 2013; Gipson et al. 2008; Joyce et al. 2000; Karaçam et al. 2010; Kost et al. 1998; Lindberg et al. 2015). However, these associations were not observed in other studies included in a literature review (Gipson et al. 2008). Studies have reported that poor mental and physical health, and high body mass index (BMI) in women before pregnancy were associated with pregnancy complications, low birth weight and preterm birth (Cnattingius et al. 1998; Haas et al. 2005; Witt et al. 2012), even after adjustments for risk factors during pregnancy (Cnattingius et al. 1998; Haas et al. 2005). Yet, changes in maternal behaviors before and during pregnancy were rarely discussed in majority of the studies (Cnattingius et al. 1998; Flower et al. 2013; Gipson et al. 2008; Haas et al. 2005; Joyce et al. 2000; Karaçam et al. 2010; Kost et al. 1998; Lindberg et al. 2015; Najman et al. 1991; Witt et al. 2012). Hence, it remains equivocal whether maternal behaviors before or during pregnancy or both may influence birth outcomes.

In order to provide better insights into the health implications of planning a pregnancy, this study aimed to (a) compare maternal demographics, behaviors before and during pregnancy, and pregnancy outcomes of women with different pregnancy planning status, and (b) test the association of pregnancy planning status with birth outcomes. We hypothesized that women who did not plan their pregnancy were more likely to engage in unhealthy behaviors before and during pregnancy, and that pregnancy and birth outcomes were less favorable, compared to women who planned their pregnancy.

## Methods

### Study participants

Out of 2034 eligible pregnant women who conceived naturally, 1152 (57%) consented to participate in the Growing Up in Singapore Towards healthy Outcomes (GUSTO) mother-offspring cohort study during the first trimester of pregnancy (at <14 weeks of gestational age based on ultrasound scan) at KK Women's and Children's Hospital and National University Hospital in Singapore between June 2009 and September 2010 (Soh et al. 2013). The women were 18 years old or above, Singaporeans or Singapore permanent residents in homogeneous parental ethnic groups (Chinese, Malay, or Indian). Pregnant women who were on chemotherapy or psychotropic drugs or who had type 1 diabetes mellitus were excluded from the beginning of the study. Written informed consent was obtained from each woman participant. This study was approved by the Centralised Institutional Review Board of SingHealth (reference 2009/280/D) and the Domain Specific Review Board of the Singapore National Healthcare Group (reference D/09/021). This trial was registered at [www.clinicaltrials.gov](http://www.clinicaltrials.gov) as NCT01174875.

### Pregnancy planning status

Two questions were administered to the pregnant women at 26-28 weeks' gestation and the responses to the questions were used to classify their pregnancy planning status. First, the women were asked to respond to a yes/ no question "Was this pregnancy planned?", and if they responded yes, they were classified as having a planned pregnancy. If they responded no, they were classified as having an unplanned pregnancy, and were then asked a 5-point Likert-scale question "To what extent do you feel enthusiastic about being pregnant right

now?" (not at all, somewhat, pretty much, very much, extremely), in order to further classify their pregnancy as mistimed or unintended, in the following way: a mistimed pregnancy was defined as a pregnancy which the pregnant woman did not plan for, but became pretty much, very much or extremely enthusiastic about by the time of questionnaire administration; whereas an unintended pregnancy was defined as a pregnancy which the pregnant woman did not plan for, and was still feeling not at all or somewhat enthusiastic about. Accordingly, the pregnancy planning status for each pregnant woman in the present analyses was planned, mistimed, or unintended.

### Maternal characteristics

Maternal baseline demographic characteristics, including the pregnant mothers' educational level (none, primary, secondary, post-secondary, tertiary), marital status (single, married, divorced), household monthly income (Singapore dollars (SGD) 1999, 2000-5999, 6000), parity (nulliparous, multiparous), age (continuous variable), and past medical history of type 2 diabetes and/or hypertension (yes, no), were captured using interviewer-administered questionnaires at the recruitment visit.

Maternal weight in early pregnancy (at 14 weeks of gestation) was retrieved from hospital case notes by trained health personnel. At 26-28 weeks' gestation, mothers' height and weight were measured using stadiometer (SECA213, Hamburg, Germany) and weight machine (SECA803, Hamburg, Germany), respectively. BMI was calculated as weight in kilogram (kg) divided by height in meter squared ( $m^2$ ).

### Maternal behaviors before and during pregnancy

Maternal behaviors before and during pregnancy, including exposure to active cigarette smoking, passive smoking (defined as daily cigarette smoke exposure at work and/or home), alcohol consumption, and folic acid supplementation, were recorded (yes/no) using interviewer-administered questionnaires at 26-28 weeks' gestation. A structured questionnaire was also completed to derive the level of physical activity before and during pregnancy. The duration (in minutes) and frequency (number of days per week) of physical activity were used to calculate the total score of physical activity in metabolic equivalents (MET-minutes/week) (IPAQ, 2005; Padmapriya et al. 2015), and a highly active level of physical activity was defined as MET-minutes/week  $\geq 3000$ .

### Pregnancy outcomes

At 26-28 weeks' gestation, maternal psychological states were assessed using the Edinburgh Postnatal Depression Scale (EPDS) and State Trait Anxiety Inventory (STAI) self-administered questionnaires. A score of  $\geq 15$  on EPDS suggested probable prenatal depression (Gibson et al. 2009). The top quartile scores on STAI-state ( $\geq 41$ ) and STAI-trait ( $\geq 43$ ) identified mothers in the GUSTO cohort with high state- and high trait-anxiety, respectively (Nasreen et al. 2010; Teixeira et al. 1999). At the same visit, mothers underwent a 75-g Oral Glucose Tolerance Test (OGTT), and a diagnosis of gestational diabetes mellitus (GDM) was made based on the World Health Organization (WHO) criteria (fasting glucose  $\geq 7.0$  mmol/l or 2-hour glucose  $\geq 7.8$  mmol/l) (Alberti and Zimmet 1998). After delivery, data on pregnancy-induced hypertension was extracted from hospital case notes.

## Birth outcomes

The gestational age (GA; weeks) of the offspring at birth was noted. Neonatal anthropometry was taken by trained clinical staff within 24 hours of birth using standardized techniques (World Health Organization 2008). Weight was recorded to the nearest 0.001 kilogram (kg) using SECA 334 baby weighing scales (SECA, Hamburg, Germany). Recumbent crown-heel length was measured to the nearest 0.1 centimeter (cm) using a SECA 210 Mobile Measuring Mat (SECA, Hamburg, Germany). Head circumference was measured to the nearest 0.1cm using a non-elastic measuring tape. Based on WHO Child Growth Standards 2006, infant weight, length and head circumference were derived as weight-for-age Z-score (WAZ), length-for-age Z-score (LAZ), weight-for-length Z score (WLZ) and head circumference-for-age Z-score (HCZ), respectively, using the WHO Anthro software (Version 3.2.2).

## Statistical analyses

Univariate multinomial logistic regressions were used to compare maternal characteristics, behaviors before and during pregnancy and pregnancy outcomes (independent variables) across pregnancy planning status (a dependent variable, where planned pregnancy is the reference group for mistimed and unintended pregnancies). In addition, univariate linear regressions were performed to test the associations between pregnancy planning status (an independent variable, where planned pregnancy is the reference group for mistimed and unintended pregnancies) and different birth outcomes (i.e. gestational age, WAZ, LAZ, WLZ and HCZ) (dependent variables). Two multivariate linear regression models were further developed to explore the strength of the associations between pregnancy planning status and birth outcomes. Potential confounders were selected based on both empirical and priori hypotheses. The first model was adjusted for maternal baseline demographics, including ethnicity, educational level, household monthly income, parity and age. The second model was additionally adjusted for maternal factors *during* pregnancy, including BMI, active and/or passive smoking, folic acid supplementation, GDM, pregnancy-induced hypertension, and anxiety levels. Maternal factors *before* pregnancy were *not* adjusted for in the linear regression models because they are partly the features of pregnancy planning status (Barrett et al. 2004). Results were presented as odds ratio (OR) or  $\beta$  (regression coefficient) with 95% confidence interval as appropriate. All statistical analyses were performed using Statistical Package for the Social Sciences, Version 19.0 (SPSS Inc. Chicago, Illinois, US).

## Results

### Study participants

There were 861 (75%) of 1152 GUSTO participants with known pregnancy planning status included in this analysis, comprising 481 of 861 (56%) who had planned pregnancy, 334 (39%) who had mistimed pregnancy, and 46 (5%) who had unintended pregnancy. The reason for exclusion of the other 291 GUSTO participants from the present analysis was the lack of response to the questions needed to classify pregnancy planning status, i.e. whether their pregnancy was planned (n=68, 6%), and the level of enthusiasm towards the pregnancy (n=223, 19%).

### Maternal characteristics

Table 1 shows the associations of pregnancy planning status with maternal characteristics. Compared to mothers of planned pregnancy, mothers who did not plan their pregnancy (in both mistimed and unintended pregnancies) were less likely to have received a tertiary-level education; less likely to have a household monthly income of SGD 2000 or above; more likely to have a past medical history; and more likely to have higher BMI. Moreover, compared to mothers who planned their pregnancy, mothers of mistimed pregnancy were more likely to be Malay and younger, while mothers of unintended pregnancy were more likely to be multiparous and older.

### Maternal behaviors and pregnancy outcomes

Table 2 shows the associations of pregnancy planning status with maternal behaviors and pregnancy outcomes. Compared to mothers of planned pregnancy, mothers who did not plan their pregnancy (in both mistimed and unintended pregnancies) were more likely to be exposed to passive smoking and less likely to consume folic acid supplement before pregnancy. Mothers of mistimed pregnancy were also more likely to be active smokers before pregnancy. During pregnancy at 26-28 weeks' gestation, mothers of mistimed pregnancy were still more likely to be exposed to passive smoking and less likely to consume folic acid supplement, but they were no longer more likely to be active smokers. In this cohort, no significant associations between pregnancy planning status and mothers' alcohol consumption as well as physical activity levels before and during pregnancy were observed.

At 26-28 weeks' gestation, fewer mothers of mistimed pregnancy developed GDM (14.3%) compared to mothers who had planned for their pregnancy (22.5%). Pregnancy-induced hypertension was uncommon in this cohort. Perhaps unsurprisingly, unintended pregnancy was significantly associated with state-anxiety and trait-anxiety.

### Birth outcomes

A total of 848 pregnant women remained in this study at delivery and gave birth to a singleton baby. Fewer than 8% were preterm deliveries (i.e. earlier than 37 weeks gestation). As shown in Table 3, there were 447 (51.9%) male and 401 (47.3%) female infants. Mean (standard deviation, SD) gestational age was 38.27 (1.48) weeks, birth weight 3.10 (0.46) kg, birth length 48.60 (2.37) cm, and head circumference 33.37 (1.47) cm.

Table 4 shows the associations of birth outcomes with pregnancy planning status. Compared to planned pregnancy, mistimed pregnancy was significantly associated with lower LAZ ( $\beta = -0.286$ , 95% CI -0.457, -0.115) and higher WLZ ( $\beta = 0.354$ , 95% CI 0.188, 0.521). After adjusting for maternal baseline demographics, the association between mistimed pregnancy and lower LAZ remained statistically significant ( $\beta = -0.191$ , 95% CI -0.376, -0.007). After further adjustments for maternal factors *during* pregnancy, the association between mistimed pregnancy and lower LAZ was no longer statistically significant ( $\beta = -0.151$ , 95% CI -0.349, 0.046). No significant association was found between unintended pregnancy and all the birth outcomes analyzed.

## Discussion

This study revealed that maternal characteristics, health behaviors before and during pregnancy, and pregnancy and birth outcomes, varied significantly across pregnancy planning status. Compared to planned pregnancy, mothers of mistimed and unintended pregnancies had less desirable baseline characteristics, less healthy lifestyles before and during pregnancy, and poorer pregnancy outcomes at 26-28 weeks' gestation. Neonates of mistimed pregnancy had shorter birth length compared to those of planned pregnancy, even after adjusting for maternal baseline demographics, but was *not* significantly different after further adjustment for maternal factors *during* pregnancy, suggesting that in terms of optimizing birth outcomes, pregnancy planning as well as preconception and early pregnancy health behaviors are crucial factors that could override subsequent maternal enthusiasm about the pregnancy.

In this study, we classified the mothers' pregnancy planning status into planned, mistimed and unintended, in which mistimed and unintended pregnancies were both unplanned but were distinguished by different levels of maternal enthusiasm about the pregnancy as self-reported at 26-28 weeks gestation. A similar way of classification was employed in a study by Carson et al. (2011), where a 'mistimed pregnancy' was defined as an unplanned pregnancy but the mother was happy about the pregnancy (this is equivalent to what is also termed as "mistimed" in this present study), and an 'unplanned pregnancy' was defined as an unplanned pregnancy in which the mother was unhappy about the current pregnancy (this is equivalent to what is termed instead as "unintended" in this present study). Najman et al. (1991) had classified an 'unwanted baby' as an unplanned and unwanted pregnancy in which the mothers had not reacted positively to the fact that they were pregnant, which would equate to an unintended pregnancy in this present study. The classification of mistimed pregnancy in our study has made it possible for us to identify whether there was any adverse pregnancy outcome that may be associated with the lack of pregnancy planning despite the mothers subsequently becoming positive about their pregnancy.

Importantly, we found that compared to neonates of planned pregnancy, those of mistimed pregnancy were indeed shorter at birth by an average of 0.46cm (0.286 Z score). Two other studies had previously found shorter birth length among neonates of unplanned pregnancies (Joyce et al. 2000; Karaçam et al. 2010). In the present study, we found that the association of mistimed pregnancy with shorter birth length remained statistically significant after adjustment for maternal baseline demographics. This means that the offspring's shorter birth length may be more related to maternal preconception health behaviors rather than the mothers' baseline demographics or their behaviors after they received news of the pregnancy and became enthusiastic despite not planning for it (i.e. a mistimed pregnancy as we defined in this study). This finding strongly suggests that pregnancy planning is of utmost importance, and that intervention strategies should be targeted as early as during the preconception stage to give the women sufficient time to change their unhealthy lifestyles before they miss the window of motivation for change (Dott et al. 2010).

The finding that shorter birth length in neonates born to mistimed pregnancy is a significant one because it has previously been found to correlate with poorer long term health. Birth

length has been suggested as a better predictor of adult height and weight than birth weight, and is a potential risk factor for adult diseases (Eide et al. 2005). Those born with shorter body length in South India have been associated with increased risk of coronary heart disease (Stein et al. 1996). Another study in Finland added that each centimeter shorter in birth length increased the risk of developing coronary heart disease by 10% (Forsén et al. 1999). In addition, an inverse association of birth length with systolic and diastolic blood pressure at age 30 years was reported in Hong Kong Chinese population (Cheung et al. 2000). In other words, shorter birth length in the offspring of mistimed pregnancy should be considered as an adverse health outcome. Longitudinal follow-up data in the ongoing GUSTO cohort of children are being collected, and could further elucidate the long term health in these offspring of mistimed pregnancy.

Maternal demographics, including ethnicity, marital status, age, education, family income and parity, have been separately reported to be significantly different between planned and unplanned pregnancies (Baydar 1995; Carson et al. 2011; Flower et al. 2013; Karacam et al. 2011; Rosenfeld and Everett 1996; Singh et al. 2013). These characteristics were comprehensively examined in the present study, and were indeed found to vary across planned, mistimed and unintended pregnancies. This study has clarified women with certain baseline characteristics whom concerted efforts of family planning education and promotion can be targeted at.

In terms of maternal behaviors before and during pregnancy, our study and previous studies (Carson et al. 2011; Dott et al. 2010; Flower et al. 2013; Gipson et al. 2008) agreed that mothers of unplanned pregnancy had greater cigarette smoke exposure than those who planned their pregnancy. Some of the other studies, however, did not agree with this finding (Gipson et al. 2008). Consistent with Dott et al. (2010), we found that mothers of mistimed pregnancy were less likely to have folic acid supplementation before and during pregnancy. While some studies (Gipson et al. 2008) showed an association between pregnancy planning status and alcohol use during pregnancy, this was not observed in our study. Our findings suggest that mothers who did not plan their pregnancy were less concerned about the importance of maintaining healthy lifestyles during pregnancy or might be unaware of taking these measures for better pregnancy and birth outcomes. Our study corroborates the study by Dott et al. (2010) that mothers of unplanned pregnancy tended to continue similar behaviors even after they became aware of their pregnancy.

In terms of maternal psychological states, Najman et al. (1991) revealed that mothers of unwanted pregnancy tended to be depressed and anxious based on Delusions-Symptoms-States Inventory during the first clinic visit at 18 weeks' gestation. In contrast, the mothers of unintended pregnancy in our cohort had high state-trait anxiety based on STAI, but no depression based on EPDS, at 26-28 weeks' gestation. The inconsistencies between studies may be due to differences in population characteristics, measurement tools, time-point of data collection, as well as definition and/or categories of pregnancy planning status.

This present study has a few limitations. First and foremost, we acknowledge that the questions used to derive pregnancy planning status have not been previously validated. Second, preterm births comprised less than 8% of the cohort and all the pregnancies carried



beyond 26-28 weeks gestation, so we were unable to study the association of pregnancy planning status with premature delivery, which is an important pregnancy outcome measure. Third, the sample size for unintended pregnancy was too small to draw firm conclusions on the outcomes of this pregnancy planning status. Fourth, we might not have accounted for all the confounding factors when deriving the association of mistimed pregnancy with shorter birth length. Lastly, data in this study were largely self-reported, and those on maternal behaviors *before* pregnancy could be subjected to recall bias because data collection took place when the women were already 26-28 weeks pregnant. It is therefore ideal to confirm our findings using a prospective study design starting from preconception. Such studies, however, are costly to undertake.

In conclusion, the present study serves to reinforce the importance of pregnancy planning in optimizing maternal and child health. Health promotion programs should highlight this message and pay particular attention to those women who have baseline characteristics that have been found to be associated with increased risk of having an unplanned pregnancy. Our finding on birth length suggests that preconception and early pregnancy factors could have overriding influence on birth outcomes and future health of the offspring. As such, there should be universal access to preconception health screening facility. In recognition that a mistimed pregnancy may still occur, emphasis must also be placed on encouraging all women of child-bearing age to adopt a healthy lifestyle at all times. Future research related to the DOHaD hypothesis should focus on preconception and early pregnancy environments in order to address unanswered questions about early critical programming windows in the developmental origins of diseases.

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### Compliance with Ethical Standards

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**Table 1**  
The associations of pregnancy planning status with maternal characteristics tested using univariate multinomial logistic regression

Characteristics	Planned pregnancy <sup>a</sup> (n=481)	Mistimed pregnancy (n=334)	Unintended pregnancy (n=46)	Unadjusted OR for mistimed pregnancy (95% CI)	P value	Unadjusted OR for unintended pregnancy (95% CI)	P value
<b>Maternal baseline demographics</b>							
Ethnicity (n, %)							
Chinese	290 (60.3)	152 (45.5)	28 (60.9)	1.000		1.000	
Malay	75 (15.6)	137 (41.0)	11 (23.9)	3.485 (2.473, 4.912)	<0.001	1.519 (0.723, 3.191)	0.270
Indian	116 (24.1)	45 (13.5)	7 (15.2)	0.740 (0.498, 1.100)	0.137	0.625 (0.266, 1.471)	0.282
Educational level (n, %)							
None/Primary/Secondary	105 (22.2)	104 (31.3)	24 (52.2)	1.000			1.000
Post-secondary	140 (29.7)	146 (44.0)	16 (34.8)	1.053 (0.737, 1.504)	0.777	0.500 (0.253, 0.988)	0.046
Tertiary	227 (48.1)	82 (24.7)	6 (13.0)	0.365 (0.252, 0.528)	<0.001	0.116 (0.046, 0.291)	<0.001
Marital status (n, %)							
Married	459 (98.3)	314 (94.9)	46 (100.0)	1.000		1.000	
Single/divorced	8 (1.7)	17 (5.1)	0 (0.0)	3.106 (1.324, 7.286)	0.009	0.000	-
Household monthly income (n, %)							
SGD 1999	38 (8.6)	56 (18.0)	13 (28.9)	1.000		1.000	
SGD 2000-5999	243 (54.7)	179 (57.6)	23 (51.1)	0.500 (0.317, 0.788)	0.003	0.277 (0.129, 0.592)	0.001
SGD 6000	163 (36.7)	76 (24.4)	9 (20.0)	0.316 (0.193, 0.518)	<0.001	0.161 (0.064, 0.405)	<0.001
Multiparous (n, %)	251 (53.1)	189 (57.4)	34 (73.9)	1.194 (0.899, 1.585)	0.220	2.506 (1.266, 4.959)	0.008
Past medical history (n, %)	5 (1.1)	12 (3.6)	4 (8.7)	3.483 (1.215, 9.984)	0.020	8.819 (2.281, 34.093)	0.002
Age (years) (mean, SD)	30.74 (4.42)	30.04 (5.55)	32.26 (5.84)	0.972 (0.945, 1.000)	0.047	1.064 (1.000, 1.132)	0.049
<b>Maternal BMI during pregnancy</b>							
BMI at 14 weeks' gestation (kg/m <sup>2</sup> ) (mean, SD)	23.33 (4.35)	24.19 (5.32)	24.92 (5.33)	1.038 (1.008, 1.070)	0.014	1.066 (1.005, 1.1320)	0.034
BMI at 26-28 weeks' gestation (kg/m2) (mean, SD)	25.91 (4.08)	26.74 (4.99)	26.88 (4.68)	1.042 (1.010, 1.075)	0.010	1.048 (0.982, 1.120)	0.159

<sup>a</sup>Reference group, OR = odds ratio, n = number, % = percentage, SD = standard deviation, CI = confidence interval, SGD, Singapore dollars, BMI = body mass index, kg = kilogram, m = meter

Table 2

The associations of pregnancy planning status with maternal behaviors and pregnancy outcomes tested using univariate multinomial logistic regression

Behaviors before and during pregnancy, and pregnancy outcomes	Planned pregnancy <sup>a</sup> (n=481)	Mistimed pregnancy (n=334)	Unintended pregnancy (n=46)	Unadjusted OR for mistimed pregnancy (95% CI)	P value	Unadjusted OR for unintended pregnancy (95% CI)	P value
<b>Behaviors before pregnancy</b>							
Alcohol consumption (n, %)	170 (35.4)	118 (35.3)	17 (37.0)	0.996 (0.744, 1.334)	0.980	1.069 (0.571, 2.002)	0.835
Active smoking (n, %)	42 (8.7)	64 (19.2)	3 (6.5)	2.478 (1.632, 3.762)	<0.001	0.729 (0.217, 2.451)	0.610
Passive smoking (n, %)	161 (34.1)	174 (52.9)	23 (50.0)	2.168 (1.625, 2.893)	<0.001	1.932 (1.051, 3.550)	0.034
Folic acid supplementation (n, %)	143 (33.3)	36 (10.9)	5 (10.9)	0.247 (0.165, 0.368)	<0.001	0.245 (0.095, 0.633)	0.004
Highly active level (n, %)	142 (29.8)	87 (26.2)	12 (26.1)	0.835 (0.610, 1.143)	0.261	0.830 (0.418, 1.650)	0.595
<b>Behaviors during pregnancy</b>							
Alcohol consumption (n, %)	8 (1.7)	4 (1.2)	1 (2.2)	0.708 (0.212, 2.371)	0.576	1.294 (0.158, 10.584)	0.810
Active smoking (n, %)	9 (1.9)	13 (3.9)	0 (0.0)	2.124 (0.897, 5.027)	0.087	0.000	0.998
Passive smoking (n, %)	127 (26.8)	149 (45.3)	21 (46.7)	2.262 (1.680, 3.045)	<0.001	2.391 (1.286, 4.444)	0.006
Folic acid supplementation (n, %)	387 (89.8)	265 (80.5)	37 (80.4)	0.471 (0.311, 0.713)	<0.001	0.467 (0.212, 1.032)	0.060
Highly active level (n, %)	89 (18.6)	54 (16.4)	6 (13.0)	0.858 (0.592, 1.245)	0.420	0.656 (0.270, 1.594)	0.352
<b>Pregnancy outcomes</b>							
Gestational diabetes mellitus (n, %)	101 (22.5)	43 (14.3)	6 (13.6)	0.573 (0.387, 0.847)	0.005	0.542 (0.223, 1.320)	0.178
Pregnancy-induced hypertension (n, %)	11 (2.3)	17 (5.1)	1 (2.2)	2.291 (1.059, 4.957)	0.035	0.949 (0.120, 7.523)	0.961
Depression (n, %)	36 (7.7)	22 (6.6)	5 (10.9)	0.847 (0.489, 1.468)	0.554	1.460 (0.543, 3.924)	0.453
State anxiety (n, %)	104 (22.3)	94 (28.2)	25 (54.3)	1.369 (0.991, 1.891)	0.057	4.144 (2.230, 7.701)	<0.001
Trait anxiety (n, %)	103 (22.1)	87 (26.1)	20 (43.5)	1.246 (0.898, 1.730)	0.188	2.711 (1.454, 5.053)	0.002

<sup>a</sup>Reference group, OR = odds ratio, n = number, % = percentage, SD = standard deviation, CI = confidence interval

**Table 3**

## Offspring's birth characteristics

Infant characteristics	Overall (n=848)	Planned pregnancy (n=473)	Mistimed pregnancy (n=329)	Unintended pregnancy (n=46)
Gender (n, %)				
Male	447 (51.9)	245 (51.8)	185 (56.2)	17 (37.0)
Female	401 (47.3)	228 (48.2)	144 (43.8)	29 (63.0)
Gestational age (weeks) (mean, SD)	38.27 (1.48)	38.32 (1.41)	38.24 (1.55)	38.02 (1.61)
Birth weight (kg) (mean, SD)	3.10 (0.46)	3.10 (0.45)	3.11 (0.48)	3.06 (0.46)
Birth length (cm) (mean, SD)	48.60 (2.37)	48.81 (2.38)	48.35 (2.36)	48.20 (2.13)
Head circumference (cm) (mean, SD)	33.37 (1.47)	33.39 (1.47)	33.36 (1.48)	33.19 (1.47)

n = number, % = percentage, SD = standard deviation, kg = kilogram, cm = centimeter

Table 4

The associations of birth outcomes with pregnancy planning status tested using univariate and multivariate linear regressions

Model/Independent variable	GA, weeks $\beta$ (95% CI)	P value	WAZ $\beta$ (95% CI)	P value	LAZ $\beta$ (95% CI)	P value	WLZ $\beta$ (95% CI)	P value	HCZ $\beta$ (95% CI)	P value
Model 1 <sup>a</sup>										
Planned pregnancy	Reference		Reference		Reference		Reference		Reference	
Mistimed pregnancy	-0.084 (-0.292, 0.124)	0.426	0.010 (-0.135, 0.155)	0.890	-0.286 (-0.457, -0.115)	0.001	0.354 (0.188, 0.521)	<0.001	-0.046 (-0.213, 0.120)	0.585
Unintended pregnancy	-0.300 (-0.747, 0.147)	0.189	-0.053 (-0.365, 0.258)	0.737	-0.302 (-0.669, 0.066)	0.107	0.282 (-0.077, 0.641)	0.123	-0.100 (-0.458, 0.259)	0.585
Model 2 <sup>b</sup>										
Planned pregnancy	Reference		Reference		Reference		Reference		Reference	
Mistimed pregnancy	-0.072 (-0.301, 0.157)	0.537	-0.048 (-0.206, 0.110)	0.552	-0.191 (-0.376, -0.007)	0.042	0.149 (-0.032, 0.329)	0.106	-0.062 (-0.247, 0.123)	0.513
Unintended pregnancy	-0.207 (-0.672, 0.258)	0.382	-0.085 (-0.407, 0.237)	0.604	-0.204 (-0.580, 0.171)	0.286	0.120 (-0.249, 0.489)	0.523	-0.101 (-0.477, 0.275)	0.599
Model 3 <sup>c</sup>										
Planned pregnancy	Reference		Reference		Reference		Reference		Reference	
Mistimed pregnancy	0.012 (-0.235, 0.260)	0.921	-0.007 (-0.173, 0.159)	0.937	-0.151 (-0.349, 0.046)	0.133	0.159 (-0.037, 0.354)	0.111	-0.026 (-0.223, 0.170)	0.792
Unintended pregnancy	-0.219 (-0.709, 0.272)	0.381	-0.018 (-0.346, 0.310)	0.913	-0.064 (-0.456, 0.327)	0.747	0.029 (-0.361, 0.419)	0.884	-0.093 (-0.481, 0.296)	0.639

GA = gestational age, WAZ = weight-for-age Z score, LAZ = length-for-length Z score, WLZ = weight-for-length Z score, HCZ = head circumference-for-age Z score,  $\beta$  = regression coefficient, CI = confidence interval BMI = body mass index, GDM = gestational diabetes mellitus

<sup>a</sup>Unadjusted

<sup>b</sup>Adjusted for maternal baseline demographics (ethnicity, mother's education level, household monthly income, parity, mother's age)

<sup>c</sup>Adjusted for parameters in model 2, plus maternal factors during pregnancy (folic acid supplement intake, GDM, pregnancy induced hypertension, active smoking, passive smoking, BMI, anxiety levels)