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Identifying trajectories of antenatal depression in women and their associations with gestational age and neonatal anthropometry: A prospective cohort study

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ABSTRACT

Objective: The present study sought to determine the longitudinal trajectories of antenatal depression and examine their associations with birth outcomes.

Method: 926 healthy women with uncomplicated singleton pregnancies within 14 weeks of gestation participated in this prospective cohort study. Women completed a sociodemographic and medical questionnaire and the locally-validated Edinburgh Postnatal Depression Scale (EPDS) in their first, second, and third trimesters, and prior to parturition. Gestational age and neonatal weight, length, and head circumference were recorded at birth. Group-based trajectory modelling characterized trajectories of antenatal depression. Analyses of covariance and covariate-adjusted linear regressions identified associations between trajectories and neonatal outcomes.

Results: Four distinct non-fluctuating trajectories of depressive symptoms were identified, with 9% women suffering from probable clinical depression throughout the pregnancy. Women in this persistently-moderate depression trajectory delivered 2.48 days earlier than in other trajectories; a one-point increase in EPDS scores was associated with an adjusted reduction of 5.82 g in birthweight.

Conclusions: Although meaningful trajectories were identified, no clinically relevant associations between persistently-moderate depressive symptoms with neonatal outcomes were found. The stability of these trajectories, however, suggests the importance of screening for depressive symptoms early in pregnancy to identify women who may benefit from greater formal and informal support.

1. Introduction

Depression is a global public health concern with rising health costs [1]. Women in their childbearing years are particularly vulnerable to developing depressive psychopathology [2], especially during trying transitional periods such as pregnancy and puerperium [3,4]. Unfortunately, these symptoms are frequently undetected and untreated [5,6], with at least one in 10 women suffering from major depression in antenatal and postpartum periods [7].

This persistent depressive symptomatology is worrying given its associations with poorer bio-psycho-socio-cognitive outcomes in offspring as early as the neonatal period [8–11]. Infants of women afflicted with depression have been found to suffer from poorer neurodevelopmental and neurobehavioral functioning [12–14], a greater number of neonatal health complications [15], and even an increased risk of perinatal complications [16]. Depression in pregnancy may even exert an antenatal influence on fetuses, via the mediated by hyperactivation of the maternal hypothalamic-pituitary-adrenal axis [17] and increased inflammatory markers [18], which may influence fetal cortisol levels [19] and maternal placental gene expression [20].

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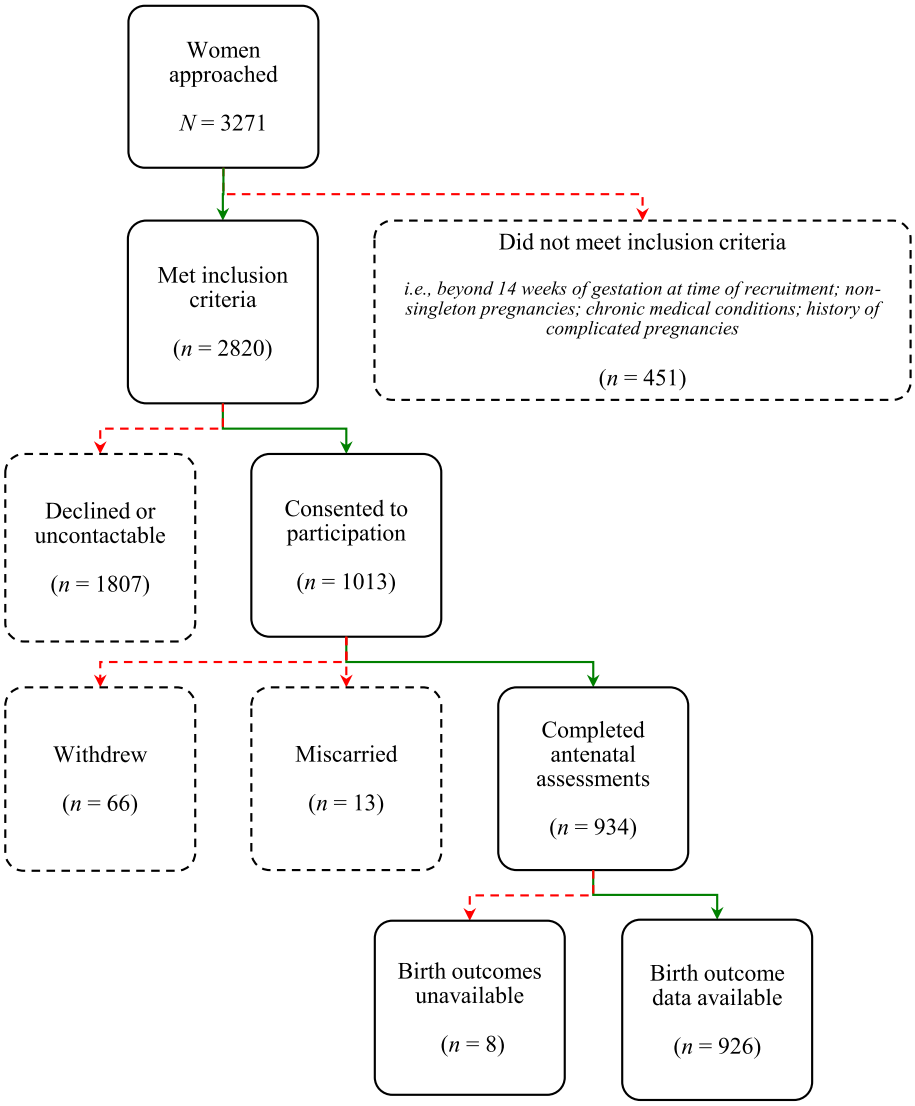

Fig. 1. Flowchart of recruitment process and sample selection for the present study.

While a few studies have verified this claim and reported depression in pregnancy to be associated with adverse neonatal outcomes such as prematurity and poorer neonatal anthropometry [21,22], the overall literature on the influence of antenatal depression on these outcomes is somewhat inconclusive [10]: a meta-analysis by Grote and colleagues [22] suggested strong associations with prematurity and lower birthweight, whereas another by Grigoriadis and colleagues [23] have suggested that there exist only modest associations with prematurity (none with gestational age) and limited associations with birthweight.

This apparent contradiction is likely the result of three shortcomings in study design and analyses. The first is that most studies ignore inter-individual fluctuations of depressive symptoms in pregnancy by employing only a single assessment at non-standardized antenatal time-points as a proxy for the entire period [24–26]. Although there have been suggestions that depressive symptoms remain stable throughout pregnancy [27–29], more recent work has suggested that depressive symptoms may instead decrease mid-pregnancy [30,31]. The second is that studies employing longitudinal designs often ignore intra-individual temporal patterns of change (trajectories) in depressive symptoms during pregnancy by employing aggregate scores to represent all women within each antenatal period. When longitudinal studies do in fact employ these trajectory analyses, they focus not on the antenatal period or associations with neonatal outcomes, but instead use antenatal assessments to predict postnatal depressive symptom trajectories [32]. The third is that the closest study assessing the patterns of change in depressive scores and their associations with preterm births only assessed depressive symptoms twice (only in the middle and end of the pregnancy) and identified significant changes in scores via minimally important differences instead of the more appropriate growth models [33].

Given these lacunae, the identification of depressive symptom trajectories specific only to the antenatal period and the exploration of their relationships with neonatal outcomes may provide greater clarity in identifying not only the influence of depressive symptoms on neonatal outcomes, but also the women who may be at risk for chronic or worsening trajectories of antenatal depressive symptoms. The aims of the present cohort study were thus to determine common temporal patterns (or trajectories) of antenatal depressive symptomatology and to examine associations of these trajectories with neonatal outcomes in a sample of Asian women. Consistent with these aims, it was hypothesized that: (1) there were identifiable latent classes of change in self-reported maternal depressive symptoms and that (2) these identified trajectories would be associated with shorter gestational ages and poorer neonatal anthropometry (weight, length, and head circumference) at birth even after controlling for potentially confounding a priori baseline maternal sociodemographic and medical variables.

2. Methods

2.1. Study design and procedures

The present study was part of a larger prospective antenatal cohort study of 926 pregnant women in Singapore (NORA Antenatal Cohort) [34]. In brief, to be eligible, participants had to be women with confirmed pregnancies via ultrasound scan within 14 weeks of gestation at time of recruitment. Participants also had to be seeking first-booking antenatal care appointments at KK Women's and Children's Hospital (KKH), a large tertiary maternity hospital in Singapore with approximately 25–30% of national births, between September 2010 and November 2013. Women with multiple pregnancies (e.g., twins or more) and chronic medical conditions such as systemic lupus erythematosus or renal disease, or a history of pregnancies complicated by aneuploidies or cervical incompetence, were excluded. Women who had consented to be in the study and had subsequently miscarried or decided to continue to care elsewhere were also considered ineligible. There were no restrictions on language, ethnicity, or nationality; however, all participants identified as Asian. Further details regarding the NORA Antenatal Cohort are available in a published study protocol [34].

Participants' assessments were performed at four antenatal timepoints that coincided with their scheduled antenatal appointments: first trimester (baseline; between 11 and 14 weeks; $M_{T1} \approx 12 + 3$ weeks); second trimester (between 18 and 22 weeks; $M_{T2} \approx 20 + 2$ weeks); third trimester (between 28 and 32 weeks; $M_{T3} \approx 29 + 5$ weeks); and prior to delivery (after 34 weeks of gestation; $M_{T4} \approx 36 + 2$ weeks). To reduce participant burden, women who defaulted or had no scheduled appointments within assessment were followed-up during the next available window (1% at T1 and T2; 4% at T3; and 14% at T4). Anthropometric data were also collected from participants at baseline and neonates at delivery. Participants who completed each assessment—regardless of data completeness—received an inconvenience fee of SGD 10. The final sample comprised 926 women; Fig. 1 details the recruitment flowchart for this study.

2.2. Ethics

Ethics approval was granted by the SingHealth Centralized Institutional Review Board (References: 2010/214/D, approved 1 September 2010; 2012/434/D, approved 19 July 2012; 2017/3075, approved 18 December 2017) and all participants provided written informed consent.

2.3. Measures

Depressive symptomatology during the pregnancy was measured using the Edinburgh Postnatal Depression Scale (EPDS; [35]), a 10-item measure examining the self-reported frequency of psychological and psychosomatic symptoms of depression over the prior week on a Likert-type scale ranging from zero (“Never” or “Not at all”) to three (“Yes, very often” or “Yes, most of the time”). Although initially developed for a postnatal population, the EPDS has been identified internationally as one of the best screening tools for repeated evaluations of antenatal depression [36–39], and has been validated for use in local antenatal populations [25,40–42]. Higher EPDS total scores (up to a theoretical maximum of 30) indicate higher levels of depressive symptomatology [43].

For this study, a more recently suggested antenatal cut-off of 14/15 for EPDS total scores at each trimester was used as a guide to denote probable clinical depression [44], instead of the traditionally used cut-offs of 12/13 [45], or the unvalidated by-trimester fluctuating cut-offs [46]. Given language preferences related to ethnicity, the EPDS was available in English, Mandarin, and Malay to participants. To ensure usability in the local context as previously suggested [43], the EPDS in these languages was forward- and back-translated. No significant differences in EPDS total scores were determined amongst the different languages at all assessments (via one-way analyses of variance [ANOVAs]; all ps $>$ 0.05). The EPDS also demonstrated acceptable internal consistency in every language at each of the four assessments (Cronbach αs = 0.70–0.91). As such, data from all participants were combined within each assessment period and demonstrated good internal reliability across the pregnancy (Cronbach αs = 0.84–0.88).

Gestational age at delivery was calculated via dating scans done within the first trimester (before 14 weeks of gestation), which are thought to be accurate to within one week. Neonatal anthropometric measurements were conducted according to routine hospital guidelines for newborn care at KKH. Within an hour of parturition, a physician or nurse measured the newborn's weight, length, and head circumference (occipital frontal circumference; OFC) at birth. Birthweight was measured in kilograms using an infant electronic (digital) weighing scale present in each delivery suite or operating theatre and were zeroed before each weighing. Neonatal length was measured in centimeters as the distance from the soles of the feet to the top of the head when the neonate was supine with head flush against the headboard with infant looking up, using an infant measuring board available in each delivery suite or operating theatre. OFC was measured in centimeters with a measuring tape placed anteriorly on the forehead above the eyebrows and posteriorly at the maximum occiput protrusion, also available in each delivery suite or operating theatre. All measurements were taken until two subsequent measurements were within the prespecified tolerance limit for measurement errors.

Demographic and medical data from participants were obtained through interviewer-administered structured questionnaires at baseline. Potential confounding lifestyle variables (such as smoking, alcohol, and coffee intake during the antenatal period) and any additional medical comorbidities during the pregnancy were recorded at each antenatal assessment.

2.4. Statistical analyses

All data underwent identification for response biases. No statistically significant differences in socio-demography were identified between participants with complete data at all four time points (83%, n = 768) and those who had missed at least one antenatal assessment. Missing data were determined to be missing completely at random (Little's $p > .05$) and thus no missing data imputation was conducted. Data were also deemed to be normally distributed and suitable for subsequent analyses. Unless otherwise specified, analyses were conducted with SPSS (version 24), and significance levels were set at 0.05.

Trajectories of depressive symptomatology across the pregnancy were estimated and identified via group-based trajectory models, which have previously been used, in other antenatal and postnatal populations [32], to identify latent classes of individuals across longitudinal data by clustering individuals into groups that follow similar trends of change [47]. Analyses were conducted via a STATA (MP version 14) macro for group-based modelling of longitudinal data [48–50], which estimated for data missing completely at random with a full maximum likelihood model [47]. As suggested elsewhere [49,51], three goodness-of-fit criteria were used to determine the best fit model: a value of twice the change in the Bayesian Information Criterion ($2\Delta BIC$) $>$ 10; a percentage membership of at least 5% in each trajectory based on previous local studies [40,41]; and an average posterior probability $>$ 0.80.

Two analytical approaches were employed to identify associations between the identified trajectories and gestational age, weight, length, and OFC at birth. The first examined differences in these neonatal outcomes between participants who were identified as having a persistently-moderate depressive symptoms trajectory and those in other trajectories via ANOVAs. The second quantified the associations between these relationships, using linear regression analyses of neonatal outcomes on mean EPDS total scores across the pregnancy. Next, to

ascertain the veracity of these results, both analytical approaches were then adjusted for a priori-identified covariates that may potentially influence neonatal outcomes via analyses of covariance (ANCOVAs) and covariate-adjusted linear regression models. Covariates adjusted for were: mother's age [52]; mother's health (body mass index [BMI] [53] and diabetes or hypertension during or before pregnancy [53,54]); and mother's lifestyle (any exercise [55], smoking [56], or use of caffeine [57], alcohol [58], recreational drugs [59], or supplements throughout pregnancy [60]). Because data for local gestational age-specific neonatal anthropomorphic measurements was only available for those born after 36 weeks of gestation [61], all models with neonatal anthropometry controlled for gestational age [62].

3. Results

3.1. Participants

The present sample of 926 participants was adequate for analyses in the present study: reliable trajectory analyses have been conducted comfortably on samples as small as 48 participants [63], and a calculated minimum sample size of 739 participants was required for subsequent neonatal outcome analyses (based on two-sided $\alpha = 0.05$, $\beta = 0.20$, as well as previously reported estimates [25]).

Table 1 details the sociodemographic variables of participants at baseline. Participants were, on average, 30.5 ± 4.5 years of age, with half ($n = 470$) identifying as ethnically Chinese) in contrast to local ethnic norms of three-quarters [64]. Six hundred and four participants (65%) had at least a tertiary-level education, which is consistent with local norms for this age group [65]; 740 (80%) stayed in public housing (93%, $n = 857$); and 605 (65%) reported total household incomes greater than SGD 3501.00, consistent with general population trends [66]. Eight hundred and seventy-one (94%) participants were also married and 887 (96%) lived with the father of their unborn child. No participants disclosed a history of depression.

Table 1
Sociodemographic variables for total sample at baseline.

Baseline variable	Total sample
Age (years)	30.54 ± 4.98
Chinese ethnicity	470 (51)
Education completed	
At least primary	14 (2)
At least secondary	308 (33)
At least tertiary[a]	269 (29)
At least quaternary[b]	335 (36)
Employed	740 (80)
Public housing	857 (93)
Total household income	
< SGD 3500	319 (35)
SGD 3501–8500	483 (52)
> SGD 8501	122 (13)
Body mass index (BMI)	24.16 ± 4.66
Not obese (< 30)	820 (89)
Obese (≥ 30)	106 (11)
Gravidity	0.65 ± 0.87
Primigravid	389 (42)
Parity	0.54 ± 0.50
Nulliparous	501 (54)
Any diabetes before/during pregnancy	116 (12)
Any hypertension before/during pregnancy	28 (3)
Any smoking during pregnancy	34 (4)
Any alcohol during pregnancy	34 (4)
Any recreational drug use during pregnancy	2 (1)
Any caffeine during pregnancy	447 (48)
Any physical exercise during pregnancy	267 (30)

Notes. Data presented as either $M \pm SD$ or n (%).
[a] Including participants with "A" Level certificates or Diplomas.
[b] Including those with Bachelor's or higher degrees.

3.2. Trajectories of antenatal depressive symptomatology

Trajectory analyses suggested that the best fitting model, with a 2ΔBIC value of 94 over the preceding lower-order model, comprised four trajectories with average posterior probability values ranging between 0.84 and 0.91. A higher order model with five classes was unstable and could not be computed given that the percentage change in ΔBIC was approaching 0. Fig. 2 presents a graphic visualization of the four distinct non-fluctuating trajectories of depressive symptomatology across the pregnancy. Trajectory 1 (37%; $n = 339$) was linear and named "persistently-no" depressive symptoms ($EPDS_{total} = 3.18–4.14$), with participants endorsing a score of 0 ("Never" or "Not at all") for a majority of the 10 items. Trajectory 2 (33%; $n = 306$) was cubic and relatively non-fluctuating, and named "persistently-mild" depressive symptoms ($EPDS_{total} = 7.04–8.16$). Trajectory 3 (21%; $n = 197$) was linear and named "persistently- subthreshold" depressive symptoms, as it was consistently below the recommended EPDS cutoff of 14/15 ($EPDS_{total} = 10.70–12.03$). Trajectory 4 (9%, $n = 84$) was linear and named "persistently-moderate" depressive symptoms as scores were consistently above the recommended EPDS cutoff of 14/15 ($EPDS_{total} = 15.75–16.40$), suggesting that these women may have consistently experienced probable clinical depression throughout the pregnancy. Naming conventions were drawn from the severity of ranges in the EPDS [67]. For subsequent analyses, participants in Trajectory 4 (persistently-moderate antenatal depressive symptoms) were then compared to the aggregate of participants in Trajectories 1–3.

3.3. Associations between trajectories and neonatal outcomes

ANOVAs suggested that participants in the persistently-moderate trajectory (Trajectory 4) delivered neonates at significantly lower gestational ages (Mean difference = 2.47 days; $F[1924] = 4.26$, $p = .039$) and with lighter birthweights (Mean difference = 109 g; $F[1924] = 4.38$, $p = .037$). However, after adjusting for covariates, ANCOVAs suggested that only the former association was significant: women in Trajectory 4 delivered neonates on an average of 2.48 days earlier than their counterparts who did not experience persistently-moderate depressive symptoms throughout the pregnancy ($F[1914] = 4.43$, $p = .036$). No other significant associations, unadjusted or adjusted, were found (for more information, see Supplementary Tables 1–4).

Because trajectories were generally non-fluctuating and persistent, EPDS total scores over the course of the pregnancy were averaged as a proxy for depressive symptoms over time.

Unadjusted linear regression analyses indicated a trend that EPDS scores may be associated with neonatal birthweight ($R^2 = 0.33$; $F[2923] = 228.73$, $p < .001$; $B = -4.91$, $p = .10$). This relationship was significant even after adjustment for covariates, with every one-point increase in average EPDS total score associated with a decrease of 5.82 g ($p = .046$) in neonate birthweight ($R^2 = 0.38$; $F(12,913) = 48.29$, $p < .001$). No other significant associations were found (for more information, see Supplementary Table 5).

4. Discussion

This is the first study employing trajectory analyses conducted on a cohort of women exclusively during the antenatal period and the only study that examines associations between these trajectories and neonatal outcomes instead of simple approximations. To date, only one other study has yet examined the influence of psychological symptoms during pregnancy longitudinally on neonatal outcomes [68], and, even then, on stress and not on depressive symptoms. Further, given the nature and relative representativeness of the cohort of this population, findings from this prospective cohort study on close to a thousand women may be generalizable locally and perhaps even internationally to women with healthy singleton pregnancies.

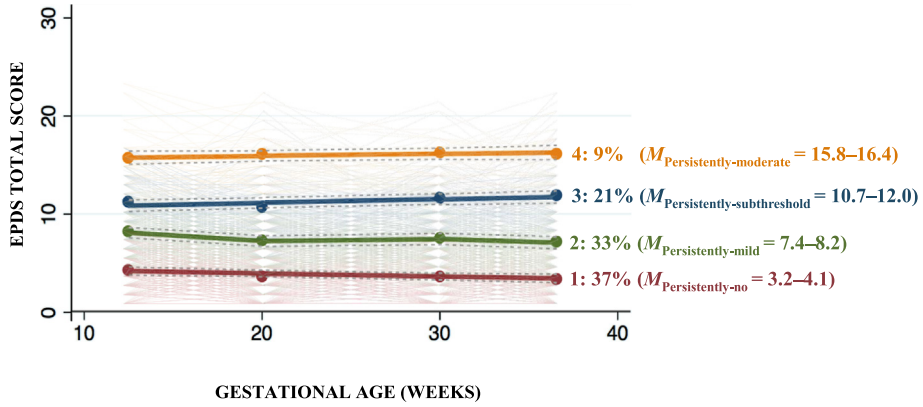

Fig. 2. Graphic visualization of the four trajectories of antenatal depressive symptomatology with associated percentage of participants within each trajectory and Edinburgh Postnatal Depression Scale total score means across time.

Trajectory analyses suggest that about one in 10 women in this study met the recommended cut-offs for probable clinical depression throughout her pregnancy. These findings are consistent with past research indicating that the local prevalence of significant depressive symptoms was between 4 and 15% [40,41,69], with an international prevalence of 12% [7]; however it is noted that cultural differences may influence these levels given that a large cohort study in Canada has recently suggested that only 3.7% of women suffered from persistently-elevated levels of depressive symptoms in the second and third trimesters [33], using the even lower EPDS cutoff of 9/10 as compared to the present study's cutoff of 14/15.

Analyses identified four common, generally non-fluctuating, temporal patterns of antenatal depression in this cohort. These findings are also in line with past research on aggregate depression scores as well as trajectory analyses exploring the transition from ante- to postnatal depression, which have suggested that depressive symptoms remain stable throughout pregnancy [70,71]. The closest comparable studies in a sample of pregnant women in the United States have suggested three similar antenatal trajectories using only third-trimester Beck Depression Inventory scores [72]; another in an Asian (Taiwanese) sample also indicated four similar trajectories of EPDS scores from the third-trimester to one-week postpartum [73]. Combined with the present study findings, antenatal depressive symptoms in healthy women may therefore be potentially represented by a more linear pattern across the pregnancy, providing more conclusive evidence for past postulations [30,31].

While it was hypothesized that antenatal depressive symptoms would influence neonatal outcomes, analyses suggested that this was supported only to a certain degree. Women in the persistently-moderate depressive symptom trajectory delivered about a third of a week earlier, although this study was unable to demonstrate a relationship between EPDS total scores (a proxy for severity of depressive symptoms) and shorter gestation. These findings are consistent with past work suggesting that elevated depressive symptoms in the second and third trimesters do not significantly increase the odds of preterm births [33].

While there were no significant differences in birthweight of babies born to women in the persistently-moderate trajectory and those in the other trajectories, every one-point increase in EPDS scores was associated with a quantifiable decrease in about 6 g in birthweight. This may suggest that while the absolute value in reduction may not be clinically significant, there potentially exists some dose–response relationship. For example, a severely depressed woman with an EPDS score of 25, as compared to a minimally depressed woman with a score of 15, might have a newborn with a relative reduction in birthweight could be as much as 60 g. These findings help quantify previously postulated associations [9], and further highlight the importance of examining these relationships with evolving methods to better account for the clinical picture.

It is also interesting to note that another study locally has suggested that the influence of depressive symptoms at a gestational age of 26 weeks is not on neonatal birthweight, but instead on birth length [25]. Aside from the different statistical methods in which groups were defined (trajectories in this study vs. at a single time point), birth length, in retrospect, may not have been a reliable a measure, given that it requires a neonate to be stretched out fully, which may have been difficult to accomplish in neonates whom were unable to relax sufficiently or had muscular contractures. Similarly, while head circumference is increasingly being used as a proxy for brain development, difficulty in measuring the circumference, especially given the use of various assisted-parturition devices, which may provide assessors with greater difficulty in determining landmarks for measurement.

4.1. Limitations and future directions

While this study did not include comorbid measures of anxiety and stress [74], multi-trajectory analyses conducted on this cohort have revealed similar patterns of trajectories and associations (data not shown), which is also supported by past work suggesting a lack of association between these variables [33]. While it may be argued that models may also have been overfitted [75], analyses excluding all covariates completely or including all socio-demography revealed similar patterns and results (see Supplementary Tables 1–5). Additionally, categorical classifications of outcome measures may often potentially yield more information; however, additional analyses in this sample revealed no unadjusted or adjusted associations between depressive symptoms and preterm births (defined as < 2500 g; n = 68; 7%; data not shown), or low birth weight (defined as before 37 weeks; n = 62; 7%; data not shown). Further, although missing data may have influenced results, analyses conducted on participants for whom only all data were available analyses also revealed similar patterns of trajectories and associations with neonatal outcomes (data not shown).

The present findings should also be interpreted within the context of both the study and prevailing culture. Women in this prospective study were recruited in their first trimester; however, some may already be overburdened by the symptoms of pregnancy and thus declined to participate. In contrast, a large cohort study of pregnant women in Singapore that recruited participants between 26 and 28 weeks, when women were likely more settled and receptive to participating in research, had a participation rate of 61% [76]. In addition, given the predominance of Asian cultural beliefs, superstitions, and taboos [77–79], women may have also declined participation in this study of adverse neonatal outcomes so as not to “jinx” their pregnancy with the potential of having such outcomes [80,81].

Even though the 12-month prevalence of any mental health disorder

is 4.4% in the local context [82], it was unsurprising that all participants also had an absence of any history of mental health issues, or perhaps were not keen on disclosing their history given the prevailing social stigma in the local context [83]. In addition, past work from the Singapore National Mental Health Surveys have suggested a very low utilization of mental health services [84], especially amongst those who were employed and more highly educated [85]. Women who may themselves have been very symptomatic and over-burdened may not have chosen to participate. As such, future studies may thus consider seeking permission to access past medical records or consider recruiting participants and investigating mental health issues prior to conception.

Future work could potentially assess whether such persistently high trajectories are associated with increased risks of perinatal complications [16], such as Apgar scores, or moderated by sleep quality or social support [86]. Future work might also consider examining the specific psychopathological diagnoses in relation to biomarkers and neonatal outcomes to further highlight women within the persistently-moderate trajectory that may be at greater risk for adverse neonatal outcomes or fetal growth restrictions [9].

4.2. Clinical implications

Findings from this study with regard to the influence of depression on neonatal outcomes may be statistically significant, but not necessarily clinically relevant [87], mirroring past work in studies on stress [68], and anxiety [23]. The complex nature of the hormonal maternal–fetal interactions, as suggested elsewhere [20], may potentially be buffered by placental gene expression [88]. As such, chronically depressed individuals may also have autoregulated these mechanisms, leading to a desensitization of processes that may have portended negative sequelae for the neonate [17].

It is, however, worrying that a significant number of women with healthy singleton pregnancies continue to experience elevated depressive symptoms throughout pregnancy that may have gone undetected and/or untreated [6]. These findings are concerning, given that previous studies have reported that 39% of those with antenatal depression often go on to experience postnatal depression [89,90]. One of the main barriers toward formal or even informal psychological and psychiatric care—not only amongst women of child-bearing age—is the prevailing stigma against seeking such care in general society [91], which is unfortunately also held amongst medical professionals [92].

This stigma toward mental health may be of especial concern in the context of predominantly Asian cultures [93,94], as well as in the context of ethnic Asian minorities, where self-concealment behaviors may obfuscate a clinical assessment of symptoms [95]. In addition, there may be peculiarities to the predominantly Asian context in Singapore (e.g., the majority of participants staying in public housing, or staying with the father of their child) that may not lend itself well to predominantly Caucasian or Western populations; however, given the potential effects on the neonate, and the sustained levels of depressive symptoms, it is perhaps essential that physicians practicing in areas with this demographic have a lower threshold when assessing these women and prompt recommendation of care.

In line with this, it is perhaps fortunate that the non-fluctuating trajectories suggest that, in tandem with the international drive for antenatal screening [96,97], efforts at screening out cases may be initiated even as early as the first trimester for participants with uncomplicated pregnancies. This is of greater importance given that it may be difficult for obstetrician–gynecologists to identify women who may be at risk for mood symptoms, which further highlights the importance of early screening. The EPDS as a screening tool has been shown to be effective even in busy specialist [98], or even general [99], outpatient settings, and should perhaps be continued well into the postpartum period [100,101].

Today, mobile applications (e.g., KKH Woman&Child HealthPedia; https://www.healthhub.sg/apps/16/apps_womenchild_healthpedia) potentially circumvent the need for the administration of lengthy questionnaires and surveys by clinic staff: EDPS screening questions are incorporated in the application for women to fill out, which prompts to seek help if high scores are endorsed. Initiatives like these can potentially enhance clinical workflows for the identification and referral of women potentially at-risk for such clinically significant symptoms [102,103], with plans to either formalize management with psychiatrists, or, for those with subclinical symptoms, focus on improving mental health literacy [104] or mental well-being [105], via mindfulness-based, yoga-based, or empowerment-focused interventions [106–110].

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Appendix A. Supplementary data

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