Trajectories of depression and anxiety symptoms from pregnancy to 24 months postpartum during the COVID-19 pandemic

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Abstract – ENG

Background: Over 1 in 5 pregnant individuals will develop symptoms consistent with perinatal mood and anxiety disorders (PMADs), making them one of the most common obstetrical complications. The COVID-19 pandemic is a unique stressor which has increased burden on the mental health of pregnant and postpartum individuals. Most studies examining the impact of the pandemic on perinatal mental health have been cross-sectional while existing longitudinal studies are limited and don't span beyond 15 months postpartum or have a representative pan-Canadian sample. Examining symptom trajectories allows for a fuller understanding of the course of depression and anxiety symptoms and tailoring of screening and referral guidelines. Despite being initially high at the beginning of the pandemic, it is unclear if anxiety and depression symptoms have persisted or diminished as the pandemic progressed, and which factors may contribute to trajectories of long-term adverse mental health outcomes.

Methods: The current study recruited 9463 pregnant people between 8-35-weeks of pregnancy from the pan-Canadian Pregnancy during the Pandemic (PdP) Cohort. Each participant completed a baseline survey between April 2020 and April 2021, and completed mental health measures at 6-, 12-, and 24-months postpartum. Using latent class mixed models, group-based trajectory analysis was used to determine trajectories of anxiety and depression symptoms. Model fit was evaluated using Bayesian and Akaike model criterion. Multinomial logistic regression analysis was conducted to compare trajectory characteristics across groups.

Results: A three-class depression symptomology model (*moderate-stable 60.9%; elevated-decreasing 26.7%; low-stable 12.4%)* and a three-class anxiety model (*elevated-increasing 20.2%; moderate-decreasing 65.85%; low-stable 14%)* was identified and considered the best fitting model. Common risk factors of depression and anxiety across groups with elevated symptoms include identifying as non-White (odds ratios [ORs] varied from 1.22 to 1.50), low household income (odds ratios [ORs] varied from 1.67 to 2.34), being single (odds ratios [ORs] varied from 1.64 to 2.29), having a history of pre-pregnancy anxiety and/or depression (odds ratios [ORs] varied from 2.53 to 3.06), poor sleep quality (odds ratios [ORs] varied from 1.07 to 1.13), unplanned pregnancy (odds ratios [ORs] varied from 1.40 to 1.82), and elevated baseline anxiety and depression at intake (odds ratios [ORs] varied from 1.27 to 9.84). Common COVID-19 pandemic-related risk factors of depression and anxiety across groups with elevated

symptoms include fear their life or their unborn baby's life was in danger (odds ratios [ORs] varied from 1.01 to 1.02), changes to birth plan due to the pandemic (odds ratios [ORs] varied from 1.82 to 1.88), decreased income due to the pandemic (odds ratios [ORs] varied from 1.44 to 1.58) and feeling more alone than usual (odds ratios [ORs] varied from 1.02 to 1.04).
Conclusion: The current study is the first to describe mental health trajectories in a large pan-Canadian sample that began at the beginning of the COVID-19 pandemic. Findings indicate clinically elevated levels of anxiety and depression from pregnancy to the postpartum period, that declined for some groups or persisted throughout the perinatal period. The COVID-19 pandemic was a unique stressor, with consequences ranging far beyond pregnancy. Understanding the depressive and anxiety trajectories of pregnant and postpartum individuals in the context of the pandemic may help to identify individuals who are at greater risk for developing PMADs. These findings could aid in the development of targeted screening and intervention strategies to prevent and mitigate the detrimental lasting impacts perinatal anxiety and depression for birthing individuals and their children.

Keywords: depression, anxiety, COVID-19, pandemic, trajectories, pregnancy, postpartum.

Abstract – FR

Contexte : Plus d'une femme enceinte sur cinq présentera des symptômes de troubles de santé mentale périnatale, ce qui en fait l'une des complications obstétricales les plus courantes. La pandémie de COVID-19 est un facteur de stress unique qui pèse sur la santé mentale des femmes enceintes et des femmes en post-partum. La plupart des études qui examinent l'impact de la pandémie sur la santé mentale périnatale sont des études transversales, tandis que les études longitudinales existantes sont limitées et ne s'étendent pas au-delà de 15 mois après l'accouchement ou n'ont pas une échantillon pancanadien représentatif. Étudier les trajectoires des symptômes permet de mieux comprendre l'évolution des symptômes de dépression et d'anxiété et d'adapter les directives en matière de dépistage et de référence. Bien que les symptômes d'anxiété et de dépression aient été élevés au début de la pandémie, on ne sait pas très bien s'ils ont persisté ou diminué au fur et à mesure que la pandémie progressait, ni quels facteurs peuvent contribuer aux trajectoires des effets négatifs à long terme sur la santé mentale.
Méthodes : L'étude a recruté 9463 femmes enceintes entre 8 et 35 semaines de grossesse dans la cohorte pancanadienne Pregnancy during the Pandemic (PdP). Chaque participante a répondu à une enquête de base entre avril 2020 et avril 2021, et a rempli des mesures de santé mentale à 6, 12 et 24 mois après l'accouchement. À l'aide de modèles mixtes à classes latentes, une analyse de trajectoire basée sur le groupe a été utilisée pour déterminer les trajectoires des symptômes d'anxiété et de dépression. La qualité du modèle a été évaluée à l'aide des critères de Bayes et d'Akaike. Une analyse de régression logistique multinomiale a été réalisée pour comparer les caractéristiques des trajectoires entre les groupes.
Résultats : Un modèle de symptomatologie dépressive à trois classes (modérée-stable 60,9 % ; élevée-décroissante 26,7 % ; faible-stable 12,4 %) et un modèle d'anxiété à trois classes (élevée-augmentée 20,2 % ; modérée-décroissante 65,85 % ; faible-stable 14 %) ont été identifiés et considérés comme le modèle le mieux ajusté. Les facteurs de risque communs de dépression et d'anxiété dans les groupes présentant des symptômes élevés comprennent l'identification ethnique comme non-blanche (les rapports de cotes [RC] varient de 1,22 à 1,50), un faible revenu du ménage (les rapports de cotes [RC] varient de 1,67 à 2,34), le fait d'être célibataire (les rapports de cotes [RC] varient de 1,64 à 2. 29), des antécédents d'anxiété et/ou de dépression avant la grossesse (rapports de cotes [RC] variant de 2,53 à 3,06), une mauvaise qualité de sommeil (rapports de cotes [RC] variant de 1,07 à 1,13), une grossesse non planifiée (rapports de

cotes [RC] variant de 1,40 à 1,82), et une anxiété et une dépression élevées au départ (rapports de cotes [RC] variant de 1,27 à 9,84). Les facteurs de risque communs de dépression et d'anxiété liés à la pandémie COVID-19 dans les groupes présentant des symptômes élevés comprennent la crainte que leur vie ou celle de leur enfant à naître soit en danger (les rapports de cotes [RC] varient de 1,01 à 1,02), les changements apportés au plan de naissance en raison de la pandémie (rapports de cotes [RC] variant de 1,82 à 1,88), la diminution des revenus en raison de la pandémie (rapports de cotes [RC] variant de 1,44 à 1,58) et le fait de se sentir plus seule que d'habitude (rapports de cotes [RC] variant de 1,02 à 1,04).

Conclusion : Cette étude est la première à décrire les trajectoires de santé mentale d'un vaste échantillon pancanadien qui a commencé au début de la pandémie de COVID-19. Les résultats indiquent des niveaux cliniquement élevés d'anxiété et de dépression de la grossesse à la période postnatale, qui ont diminué pour certains groupes ou ont persisté tout au long de la période périnatale. La pandémie de COVID-19 a été un facteur de stress unique, dont les conséquences vont bien au-delà de la grossesse. Comprendre les trajectoires de dépression et d'anxiété des femmes enceintes et des femmes en post-partum dans le contexte de la pandémie peut aider à identifier les personnes qui sont plus à risque de développer des troubles de santé mentale. Ces résultats pourraient contribuer à l'élaboration de stratégies de dépistage et de gestion des risques pour les femmes enceintes et les femmes en postpartum, ainsi qu'à l'amélioration de la qualité de vie des femmes enceintes et leurs enfants.

Mots-clés : dépression, anxiété, COVID-19, pandémie, trajectoires, grossesse, post-partum.

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Contribution of Authors

The PdP study was conceptualized, funded, and managed by Dr. Gerald Giesbrecht, Dr. Catherine Lebel, and Dr. Lianne Tomfohr-Madsen. Kelsey Davis did the literature review, conducted statistical analyses and wrote the first draft of this manuscript. Jenna Jessa and Guillaume Elgbeili were consulted for methodology and statistics. The supervising committee provided guidance on methodology and rationale. Dr. Tuong-Vi Nguyen and Dr. Lianne Tomfohr-Madsen provided feedback on all sections of the manuscript.

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Chapter 1: Introduction

Maternal Mental Health in Canada

More than 350,000 individuals become pregnant in Canada every year [1, 2]. Up to 20% of child-bearing individuals experience a perinatal mood and anxiety disorder (PMAD) during the perinatal period [3-5], with many more reporting sub-clinical symptoms. This includes antenatal and postnatal depression, obsessive-compulsive disorder, post-traumatic stress disorder (PTSD) and postpartum psychosis. Approximately 50% of birthing individuals who present with mental health problems in the postnatal period report antenatal onset [6]. Maternal depression, anxiety, and stress are all associated with detrimental outcomes in both the birthing parent and child [7, 8]. Perinatal mental health problems are the most common complication of child-bearing [9], and there is an urgent need to advance research, identification and management practices.

COVID-19 and Mental Health

Since it was initially identified in December of 2019, the novel coronavirus (COVID-19) spread rapidly across the glove resulting in devastating health implications. Implications included nearly seven million global fatalities [10], strained healthcare systems, and economic instability [11]. With a limited understanding of its pathogenesis, paired with a rapid spread of the virus among individuals and the absence of definite treatments and approved vaccines (at the time), had prompted the government to implement compulsory drastic public health measures. Mobility restrictions, stay-at-home orders and social distancing practices were deemed necessary to curb transmission rates. Prolonged periods of decreased social contact combined with uncertainty of the future and living with numerous changes brought about by COVID-19 resulted in an increase in distress and adverse mental health outcomes for many people [12, 13].

The physical health consequences of the virus were significant. However, the psychological and social consequences of the virus have been shown to also be devastating [14]. Individuals have had to experience physical isolation from loved ones and communities, and daycares/educational facilities worldwide were forced to close. In addition, previous research has long demonstrated infectious disease outbreaks contribute to increased symptoms of depression

and anxiety. For instance, a study involving 139 Ontarians who were quarantined during the SARS outbreak showed symptoms of post-traumatic stress disorder (PTSD) (28.9%) and depression (31.2%) shortly after the outbreak [15]. Several other studies have linked quarantine to symptoms of anxiety and PTSD, sometimes with long-term effects [12]. Another Canadian study reported 37.4% of Canadians experienced increased psychological distress due to the pandemic [16].

It should also be noted that the pandemic not only resulted in negative distress but also potentially positive improvements for certain individuals. These include improvements in work-life balance, enhanced family dynamics, and increased feelings of closeness with loved ones [17]. Understanding which factors contribute to greater mental health resilience in periods of great stress can help prevent adverse outcomes in periods of future adversity.

COVID-19 and Maternal Mental Health

The period of pregnancy and early postpartum is known to make an individual more susceptible to stress and mental health issues [6, 18]. Unfortunately, this vulnerability has been heightened during the COVID-19 pandemic. Individuals in the perinatal period faced added challenges, such as attending regular pre and postnatal appointments at clinical sites where people with COVID-19 may be present or where waiting rooms made social distancing difficult. Some were required to give birth at a moment when health services are strained, or with support systems restricted [19]. Birth plans needed to be revised as hospitals limit the number of non-essential people permitted on site. Further, information on the transmission of COVID-19 from pregnant individual to fetus or its transmission through breastmilk was limited, thus further instilling fear [20]. Infection mitigation strategies such as stay-at-home orders and social distancing contributed to increased maternal symptoms of depression and anxiety [21, 22].

Existing evidence documenting the adverse impact of COVID-19 on perinatal mental health symptoms is largely derived from cross-sectional analyses [23]. A rapid review and meta-analysis conducted from December 2019 until February 2021 found a worldwide pooled prevalence of depression to be 25.6% and 30.5% for anxiety pregnancy [2]. Preliminary analyses using data from this present cohort during the early stages of the pandemic found 37% reported

clinically relevant symptoms of depression and 57% reporting clinically relevant symptoms of anxiety [24]. These rates are 3-4 times higher than similar pre-pandemic Canadian pregnancy cohorts [25]. Another Canadian study observed elevated visit rates across provider types for diagnoses of anxiety, depressive and alcohol or substance abuse disorders among postpartum individuals in the first year of the pandemic [26]. Events such as epidemics, pandemic and natural disasters present themselves as opportune moments to better understand the effects of objective stress exposure and individual's subjective experience of distress over time, especially during pregnancy and postnatal period [27].

Economic Impact of Untreated PMAD's

Besides the significant human suffering caused by PMADs, their economic impact has been highlighted through cost analyses conducted in the the United Kingdom (UK), United States and Australia. According to Bauer et al. (2014), untreated PMADs in the UK alone were estimated to cost approximately £8billion per year [3]. Prior estimations ascribe 25% of the economic costs related to perinatal mental health disorders (PMADs) to the mothers themselves [28-30], with 75% of these costs derived from adverse effects on exposed children, who display greater mental health vulnerability until the age of 18 [28, 31, 32], higher rates of adverse neonatal outcomes [33-36] as well as developmental delays later on during infancy and toddlerhood [37, 38]. Maternal costs of untreated perinatal mental health disorders, include suicide, infanticide, decreased productivity and loss of income, higher use of health care services and long-term disability [29, 39]. In the US, the economic impact of PMADs is estimated to be around $18bn per year, with approximately 40% of these costs associated with the negative consequences of PMADs on infant and child outcomes, assessed from birth until the age of 5 [40]. Although cost analyses from Canada have not been reported, existing prediction models suggest that the costs are likely to exceed $6.7 billion [41].

It is important to note that these prevalence statistics used to determine economic costs do not account for the COVID-19 pandemic and, therefore, may underestimate the true expenses associated with untreated PMADs. Identifying factors and time periods that contribute to greater mental health vulnerability during the perinatal period can aid in the detection and earlier intervention of PMADs, which has the potential to offset some of these high economic costs.

Intergenerational Consequences of Perinatal Mental Health Conditions

There is also substantial evidence for the effects of PMADs on child development. For example, maternal prenatal anxiety and depression predicts an increased risk of adverse neonatal outcomes [5, 35, 42, 43] and have been linked to low birth weight, pre-term birth and intrauterine growth restriction [43-47]. There is considerable evidence for the effects of PMADs on child development, independent of birth outcomes, that includes cognitive and socio-emotional development [32, 48-53]. These effects are evident in childhood and persist until at least early adulthood [32, 54]. In fact, children exposed to PMADs display greater mental health vulnerability [3, 32, 55], higher rates of adverse neonatal outcomes [34, 35, 42, 43] and developmental or psychiatric disorders during infancy, childhood and adolescence [37, 38]. Thus, exposure to maternal stress in-utero may have consequences lasting beyond infancy.

Psychosocial Factors that Contribute to Maternal Mental Health

There are several psychosocial risk factors that are associated with perinatal mood and anxiety disorders (PMADs). Social support is known to reduce the risk for perinatal depression and anxiety [56]. Individuals in the perinatal period who have less social support tend to experience more symptoms of depression compared to those with higher levels of social support [21, 57-59]. Additionally, postnatal depression has also been found to be inversely associated with social support. Similar trends have been shown with antenatal anxiety [60]. Moreover, poor sleep quality is associated with higher risk for prenatal and postpartum depression and anxiety [25, 61]. Sleep disturbance and impairment is already a common occurrence in pregnancy [62] and the postpartum period [63], and may be exacerbated due to the pandemic.

Moreover, maternal history of early-life adversity [64, 65], notably a history of maltreatment or sexual abuse are linked to increased risk for antenatal depression [66]. The lack of self-compassion [67], poor maternal physical health [68], medical disorders of pregnancy [69], complicated or traumatic deliveries [70] , and/or maternal personality traits [64, 71] have all been associated with increased likelihood of depressed or anxious mood in the antenatal or postpartum period. It is thus important to identify individuals in the perinatal period who may suffer from the compounded risk of anxiety, depression, and such risk factors to provide earlier intervention to prevent adverse perinatal outcomes.

Trajectories of Mental Health during Pregnancy and Postpartum

There is growing evidence that the symptoms of depression and anxiety experienced during pregnancy and postpartum can vary are heterogeneous, and are highly diversified in their timing, duration, and intensity [72-74]. This diversity underscores the need for individualized approaches to treatment, support, and identification. Longitudinal studies have been conducted to describe mental health outcomes during pregnancy and the postpartum period, and to determine when symptoms are likely to first occur or worsen. For some, anxiety and/or depression can start off high during pregnancy, decrease slightly over time and then will spike in the early postpartum period before decreasing again [75]. Others may have high anxiety and depression throughout the postpartum period with an antenatal onset. Others may not develop any symptomology during pregnancy, but only in the postpartum period [76-78]. Due to the variability in reported mental health based on individual characteristics, it is often advantageous to identify specific subgroups of birthing individuals for whom changes in mental health follow distinct trajectories.

Studies examining mental health trajectories in Canadian perinatal cohorts are limited. In 2016, Bayrampour et. al. identified five distinct trajectories of depression and anxiety symptoms in a Canadian community cohort (n=1445) from pregnancy until 12-months postpartum [79]. Findings captured heterogeneity of depression and anxiety symptoms over time and identified risk factors associated with high symptom groups. However, trajectory analyses did not expand beyond 12 months postpartum. Another study examined maternal depressive symptoms across seven prospective longitudinal community-based cohorts (n=11563) from pregnancy until 24 months postpartum [80]. Their trajectory analyses revealed three consistent groups with low, mild, or high levels of depressive symptoms. The findings indicate that these trajectory patterns remained stable from early pregnancy up to two years post-delivery, even among those with clinically significant levels of depression, further emphasizing the importance of understanding the timing and persistence of maternal depressive symptoms. Trajectory analyses looking at perinatal anxiety until 24 months have yet to be completed.

To date, only one Canadian study has examined mental health trajectories from pregnancy into the postpartum period during the COVID-19 pandemic [81]. They found perinatal distress was relatively stable from the pregnancy to 6 weeks postpartum and then declined from 6 weeks to 15 months postpartum, with higher education, greater social support, and lower impact of COVID-19 associated with decreased distress during pregnancy. Limitations of this study include a relatively small sample size (n=304), lack of generalizability to the Canadian population, and mental health symptoms being evaluated until only 15 months postpartum, despite studies showing mental health symptoms can persist well beyond the first year postpartum [82].

Identifying those who are at high risk for experiencing anxiety and depression symptoms, or alternatively, characteristics of those demonstrating resilience to poor mental health outcomes, could aid in developing targeted treatment strategies and more nuanced explanatory frameworks related to perinatal mental health. By examining the varying patterns of depressive and anxiety symptoms, we can work towards creating personalized treatment and prevention methods. Studying the differing time courses of these symptoms and their predictors may help understand the potential diverse causes, outcomes, and long-term prognoses.

Objectives and Hypotheses of the Current Study

Objective 1*:* To examine and characterize empirically defined trajectories of maternal depressive symptoms from pregnancy to 24-months postpartum in a Canadian cohort of birthing individuals during the COVID-19 pandemic.
Hypothesis 1*:* There will be identifiable subgroups of high and low depressive symptomology trajectories over the course of pregnancy into the postpartum period, which can be predicted based on self-report symptomology at the first assessment.

Objective 2: To examine and characterize empirically defined trajectories of maternal anxiety symptoms from pregnancy to 24-months postpartum in a Canadian cohort of birthing individuals during the COVID-19 pandemic.
Hypothesis 2*:* Based on existing literature, we expect to see similar trends as the depression symptom trajectories. There will be identifiable groups of high, low, and stable depressive

symptomology over the course of the perinatal period. We also anticipate overall elevated levels of anxiety symptoms in pregnancy and postpartum compared to pre-pandemic cohorts with similar demographic profiles.

Objective 3*:* To describe the demographic, psychosocial, obstetric, and COVID-19-related characteristics of birthing individuals in each trajectory group.
Hypothesis 3: We hypothesize participants in the elevated depressive and anxiety trajectory classes will have decreased social support, greater obstetrical complications, a history of childhood trauma, lack of self-compassion, and demographic profiles corresponding with lower SES.

Chapter 2: Methods

Participants

To address the first and second objectives, the data used for the current analyses uses data collected as part of a larger study, Pregnancy during the COVID-19 pandemic (PdP), which assesses the mental health and well-being of pregnant and post-partum individuals during the COVID-19 Pandemic [83]. This study recruited pregnant individuals from across Canada between April 2020 and April 2021 via social media to complete a series of online surveys at different timepoints during their pregnancy, and post-partum. Participants were eligible to participate if they were below 35 weeks' pregnant, ≥17 years of age, able to read and write in English or French, and lived in Canada. Once enrolled in the study, participants were then sent a series of follow-up questionnaires at 1, 2, 3, 5, 7, and 9 months after initially joining the study (until they give birth). Once they give birth, participants are asked to fill out additional questionnaires at 3, 6, 12, and 24 months postpartum. Data from intake, 6-, 12- and 24-months postpartum were used in this analysis. All participants are Canadian residents and had a confirmed pregnancy <35 weeks' gestation at the time of recruitment. Remuneration for participation was a $10 gift card after the completion of each survey. All data was collected and stored in REDCap, a secure, online data collection program for research studies [84]. This study was approved by the Conjoint Health Research Ethics Board (CHREB) at the University of Calgary, REB20–0500.

A total of 856 participant records of were excluded from this analysis. Participants were excluded if they experienced a miscarriage (n=150), Loss/neonatal death (n=9), requested to be removed (n=226), terminated their pregnancy (n=9), miscarriage/neonatal death (did not specify which) (n=20), were a surrogate (n=5), incomplete intake data (n=337), lost to follow-up (email no longer valid) (n=3), withdrawn at the discretion of PIs (n=1), over 35 weeks at intake (n=96) and unspecified (n=2). Additionally, participants were excluded from the anxiety trajectory analysis if they reported no anxiety data (n=802) data across all four time points. Participants were excluded from the depression trajectory analysis if they reported no depression data (n=776) data across all four time points. A total of 9463 participants were included in the depression trajectory analysis, and 9437 participants were included in the anxiety trajectory analysis.

Measures

Demographic information. At the initial survey, participants provided comprehensive demographic information including their age, birthdate, postal code, marital status, employment status, immigration status, ethnicity, level of education obtained, household income range, gender identity, and prior medical history.

Obstetric Measures. Participants were asked to provide information on parity, delivery mode, whether the pregnancy was planned, preterm birth, obtaining prenatal care and miscarriage history.

Social Support. Levels of social support were assessed using the interpersonal Support Evaluation List (ISEL) short form. The ISEL-SF evaluates ways in which others affect persons' responses to stressful events [85]. The ISEL-SF consists of a list of 12 statements concerning the perceived availability of potential social resources. The items are counterbalanced for desirability; that is, half the items are positive statements about social relationships, while the other half are negative statements. Items each fall into one of three subscales: tangible support, appraisal support, and belonging support. Higher scores indicate greater levels of perceived support. Good internal consistency for the ISEL was found in the current sample (Cronbach alpha = 0.88).

Depression Symptoms. Perinatal depressive symptoms were assessed using the Edinburgh Postnatal Depression Scale (EPDS) [86, 87]. The EPDS is a 10-item self-report scale designed to screen for perinatal depression with well-established sensitivity and specificity [88]. It is the most common screening tool for maternal depression (e.g., Department of Health, 2018). Participants reported on their symptoms of depressed mood in the past 7-days. This self-reporting questionnaire can produce scores ranging from 0-30. Higher scores represent more elevated depression symptoms. Scores ≥13 are used to identify individuals with clinically concerning levels of depression and are often consistent with a diagnosis of major depressive disorder [86]. Sensitivity ranges from 38-43% for a cut-off of 13 on the EPDS (depending on pregnancy trimester) and specificity is 98–99% [89]. Good internal consistency for the EPDS was found in the current sample (Cronbach alpha = 0.88).

Anxiety Symptoms. Perinatal anxiety symptoms were assessed using the PROMIS Adult Anxiety Short Form 7-item questionnaire. Participants indicated the degree to which they experienced symptoms of anxiety within the past 7 days [90]. Each of the items that make up this scale is measured using a 5-point Likert scale from 1 (never) to 5 (always). Higher scores represent a higher frequency of anxiety symptoms. Raw scores were converted to t-scores, with possible t- t-scores ranging from 36.3 to 82.7. A t-score of 50, with a standard deviation of 10, is representative of average anxiety found in the general American population. Therefore, t-scores of 60-69.9 are considered moderately elevated anxiety symptoms and scores above 70 are considered severely elevated [90]. Good internal consistency for the PROMIS Anxiety scale was found in the current sample (Cronbach alpha = 0.93).

Self-Compassion. Self-compassion was assessed using the short-form version of the Self-Compassion Scale (SCS) [91]. This 12-item scale is derived from the original 26-item scale and has a near perfect correlation with the long scale when examining total scores ($r \geq 0.97$ all samples). Participants are asked to report how often they would behave in the stated manner. Each of the items that make up this scale are measured using a 5-point Likert scale from 1 (almost never) to 5 (almost always), with higher scores representing increased levels of self-compassion. Good internal consistency for the short-form SCS was found in the current sample

(Cronbach alpha = 0.87).

Sleep Disturbance and Impairment. Sleep disturbance and impairment were assessed using the National Institutes of Health Patient-Reported Outcomes Measurement Information System (PROMIS) Sleep Disturbance and Sleep-Related Impairment short form scales [92]. The Sleep Disturbance scale consists of eight questions that inquire about various sleep disturbances, including restlessness, difficulty falling asleep, and trouble staying asleep. The questions are rated on a 5-point Likert scale and include items such as "I had difficulty falling asleep" and "I had trouble staying asleep". The Sleep-Related Impairment scale assesses daily challenges related to sleep disturbance, such as poor concentration, feeling irritable and difficulty getting things done. Higher scores indicate greater sleep disturbance or sleep-related impairment. Both PROMIS sleep measures have demonstrated acceptable convergent, construct, and discriminant validity in both healthy populations and those with clinical sleep disorders. Good internal consistency for the short-form SCS was found in the current sample (Cronbach alpha = 0.93).

Maternal Childhood Maltreatment. Adverse childhood experiences were assessed using the Adverse Childhood Experiences Questionnaire 10-item version (ACE-10). This 10-item scale assesses the exposure to 10 types of ACEs (emotional, physical and sexual abuse, emotional and physical neglect, and five household dysfunctions: parental separation/divorce, household physical violence, household substance abuse, household mental illness or suicide attempt, incarcerated household member). This version of the scale showed Good internal consistency (Chronbach alpha = 0.80) and adequate internal validity ($r = 0.28–0.70$, $p < 0.001$) [93]. Good internal onsistency for the ACE-10 was found in the current sample (Cronbach alpha = 0.72).

COVID-19 Impact. Participants were asked several questions regarding the impact of the pandemic on their lives. This includes impact on finances, threat to health, threat to baby's health, changes to birth plan and feelings of isolation.

Statistical Analyses

Descriptive Analysis

Descriptive analyses were conducted using SPSS Statistical software (SPSS Version 28.0, IBM). Sample means of demographic variables, including age, birthdate, gestational age at each timepoint, postal code, marital status, employment status, immigration status, ethnicity, level of education obtained, household income range, parity and prior medical history were summarized using descriptive statistics. Analysis of key variables including sample means for depressive and anxiety symptoms were calculated. Percentages of individuals above clinical cut-offs were calculated for each key variable.

Trajectory Analysis

Trajectory analyses were conducted using R statistical software (R version 4.1.3), R Studio 1.0 and SPSS statistical software (SPSS Version 28.0, IBM.)

Trajectory Classes and Model Selection

Trajectory analyses utilized latent class mixed modeling analysis (LCMM 1.7.8 package in R) to model anxiety and depression trajectories over time, and to assign participants to trajectory membership [94]. LCMM assumes that the population is heterogenous and divided into distinct groups, and seeks to identify those groups as they change over time [94]. This type of modeling will identify the optimal shape of each trajectory, number of groups, and proportion of individuals belonging to each group. It is possible that individual trajectories may not perfectly match the group trajectory, individuals are identified and classified based on patterns of change over time, and are assumed to follow the same patterns of trajectories as other individuals within their respective group [95]. LCMM allows for analyses with missing data points [96].

Fifty models were initially individually developed for trajectories of pain intensity, pain catastrophizing and pain interference, but adapted were adapted to anxiety and depression symptoms for the purpose of the present study. Model development included: 1) the consideration of the number of distinct trajectory groups (1 to 5), 2) the investigation of linear and quadratic spline models (2 to 5 knots) [97], and 3) the incorporation of a quadratic temporal term. Linear and quadratic temporal terms, as well as the participant were considered as random

effects. Model fit was evaluated using both the Akaike information criterion (AIC) and the Bayesian information criteria (BIC). The AIC indicates the statistical parameter at which the model complexity outweighs the model fit. This is similar to the BIC, which evaluates models with a more stringent threshold towards penalization of model complexity. Model fit improvement amongst developed models was indicated by a difference in 10 for both AIC and BIC diagnostics [98]. Identification of the best model fit was determined by the lowest sum of the AIC and the BIC, with a minimum class membership of 5%. Following the identification of the best model fit, the posterior probabilities of membership for each trajectory class were determined. The posterior probabilities of trajectory membership are calculated by averaging the individual posterior probabilities of trajectory membership of individuals assigned to each trajectory class. A minimum posterior probability of 70% across trajectory groups are considered indicative of adequate classification [99].

The 3-quantile spline methodology, which performs separate regressions at the 25th, 50th, and 75th quantiles, best improved our trajectories. Overall, based on statistical parameters, a 3-class, 5-equidistant spline, quadratic model with random intercept and slope was considered the best fit for depression. A 3-class, 3-equidistant spline quadratic model with random intercept and slope was considered the best fit for anxiety.

An outline of model fit diagnostics can be found in Table 1 for depression trajectories, and Table 2 for anxiety trajectories. Our final depression and anxiety trajectory model is shown in Figure 1 and Figure 2.

Table 1. Depression symptomology model fit diagnostics (requirement of ≥ 5% trajectory membership)

Number of Trajectories	[a]Linear		[a]Quadratic		Percentage per Trajectory	
	[b]AIC	BIC	AIC	BIC	Linear	Quadratic
Without random effects						
1	125295	125352	125172	125236	100	100
2	121803	121881	121695	121788	64 | 36	64 | 36
3	120777	120877	120669	120780	57 | 25 | 18	25 | 57 | 18
4	120578	120699	120459	120610	51 | 13 | 29 | 7	28 | 13 | 52 | 7
5	120523	120666	120372	120551	48 | 1 | 23 | 23 | 5	26 | 14 | 52 | 1 | 7
With random intercept and slope						
1	120510	120589	120364	120472	100	100
2	120488	120588	120370	120506	1 | 99	52 | 48
3	120455	120577	**120294**	**120459**	69 | 17 | 14	**61 | 27 | 12**
4	120505	120648	120297	120490	73 | 0 | 3 | 24	29 | 6 | 56 | 9
5	120430	120595	120316	120538	1 | 11 | 70 | 17 | 1	61 | 17 | 0 | 0 | 22

AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion
[a]Timepoint since initial survey considered as either a linear (time) or linear + quadratic term (time + time^2)
[b]Using sum of AIC and BIC to determine best model

Table 2. Anxiety symptomology model fit diagnostics (requirement of ≥ 5% trajectory membership)

Number of Trajectories	[a]Linear		[a]Quadratic		Percentage per Trajectory	
	[b]AIC	BIC	AIC	BIC	Linear	Quadratic
Without random effects						
1	144127	144176	143967	144025	100	100
2	140316	140388	140132	140218	60 | 40	58 | 42
3	139354	139447	139151	139266	54 | 25 | 21	25 | 52 | 23
4	139007	139122	138791	138934	32 | 14 | 49 | 5	32 | 13 | 49 | 5
5	138917	139053	138701	138872	20 | 1 | 46 | 29 | 4	19 | 1 | 46 | 29 | 5
With random intercept and slope						
1	138906	138978	138681	138781	100	100
2	138912	139005	138577	138706	51 | 49	1 | 99
3	138882	138996	**138567**	**138724**	74 | 10 | 16	**20 | 66 | 14**
4	138922	139058	138621	138807	6 | 51 | 3 | 41	0 | 12 | 76 | 12
5	138927	139085	138609	138824	95 | 0 | 0 | 0 | 5	4 | 4 | 7 | 77 | 8

AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion
[a]Timepoint since initial survey considered as either a linear (time) or linear + quadratic term (time + time^2)
[b]Using sum of AIC and BIC to determine best model

Factors Associated with Trajectory Class

Upon final model selection and assignment of trajectory membership, SPSS Version 29.0 was used to determine the characteristics of distinct trajectory groups and baseline associations

of trajectory membership. Baseline characteristics of each trajectory class were examined using χ^2 tests for categorical variables or Kruskall Wallis tests (≥2 trajectories) for continuous variables. Dunn-Bonferroni post-hoc tests were used for pairwise comparisons. Variables were non-parametric, and thus reported as median [interquartile range]. To identify critical associations of trajectory membership multinomial (>2 trajectories) logistic models were used. Odds ratios (OR) and 95% confidence intervals (CI) were presented to illustrate the clinical impact of each selected variable on individual trajectories.

Chapter 3: Results

Sociodemographic Characteristics

Sociodemographic characteristics at baseline of participants included in the depression (EPDS) trajectory analysis are presented in Table 3.

Table 3. Sociodemographic *c*haracteristics of our cohort at baseline (N = 9463).

Sociodemographic variables	*M(SD)*
Maternal Age at intake	31.9 (4.4)
Gestational Age at intake	20.8 (8.7)
Gestational Age at birth	39.3 (1.7)
	N (%)
Ethnic Origin (Race)	
White (Caucasian)	7777 (82.2)
Mixed Race or Other	434 (4.6)
South Asian (e.g., East Indian, Pakistani, Sri Lankan)	233 (2.5)
Hispanic/Latinx	175 (1.8)
Chinese	139 (1.5)
Metis	129 (1.4)
First Nations	112 (1.2)
Black	112 (1.2)
Filipino	102 (1.1)
West Asian (e.g., Afghan, Iranian)	40 (0.4)
Southeast Asian (e.g., Cambodian, Indonesian)	34 (0.4)
Korean	16 (0.2)
Inuit	4 (0)
Missing	157 (1.7)
Education	

Doctorate Degree	290 (3.1)
Master's Degree	1736 (18.3)
Undergraduate Degree	3683 (38.9)
College/Trade School	2354 (24.9)
High School Diploma	748 (7.9)
Less than HS Diploma	102 (1.1)
Missing	112 (1.2)
Annual household income (2019)	
≥$200,000	924 (9.8)
$150,000 to $199,999	1642 (17.3)
$100,000 to $149,999	2986 (31.5)
$70,000 to $99,999	1841 (19.5)
$40,000-$69,999	1211 (12.8)
<$39,999	705 (7.5)
Missing	157 (1.6)
Birth Country	
Canada	8056 (85.1)
Other	1247 (13.2)
Missing	160 (1.7)
Couple Status	
Married	5867 (62.0)
Common Law	3085 (32.6)
Single	340 (3.6)
Separated/Divorced	58 (0.6)
Widowed	1 (0)
Missing	112 (1.2)
History of Health Conditions Pre-Pregnancy	
Anxiety	3870 (40.9)
Depression	1900 (20.1)
Asthma	1133 (12.0)
Hypertension	106 (1.1)
Polycystic Ovarian Syndrome (PCOS)	560 (5.9)
Infertility	841 (8.9)
Obesity	818 (8.6)
Health Conditions During Pregnancy	
Gestational Diabetes	387 (4.1)
Gestational Hypertension	124 (1.3)
Pre-eclampsia	38 (0.4)
Anxiety	312 (35)
Depression	168 (12.3)
Province of Residence	
Ontario	2638 (27.9)
Quebec	2389 (25.2)
Alberta	2003 (21.2)
British Columbia	1271 (13.4)
Manitoba	362 (3.8)
Saskatchewan	268 (2.8)
Nova Scotia	208 (2.2)
New Brunswick	139 (1.5)
Newfoundland	89 (0.9)

Prince Edward Island	38 (0.4)
Yukon	36 (0.4)
Northwest Territories	18 (0.2)
Gender Identity	
Female	9449 (99.8)
Genderqueer/Gender non-conforming	9 (0.1)
Other/Prefer not to answer	5 (0)
Parity	
Nulliparous	4395 (46.5)

Mean mental health symptomology during pregnancy and early postpartum

The prevalence of clinically significant depressive symptoms, as defined by a score of 13 or above was 33.5% (during pregnancy), 27.1% (6 months postpartum), 17.2% (12 months postpartum), and 22.7% (24 months postpartum). The prevalence of clinically significant anxiety symptoms as defined by a t-score of 60 and above was 46.9% (during pregnancy), 35.9% (6 months postpartum), 29.3% (12 months postpartum), and 34.3% (24 months postpartum) (Table 4).

Table 4. Descriptive statistics of key mental health across time

Variable	Time 1 Baseline (<35 weeks GA)		Time 2 6 months pp		Time 3 12 months pp		Time 4 24 months pp	
n(EPDS scores)	9151		3782		4095		3404	
n(PROMIS Anx scores)	9120		3772		4094		3404	
	M(SD)	*n (%)* above clinical cut-off or general population averages	*M(SD)*	*n (%)* above clinical cut-off or general population averages	*M(SD)*	*n (%)* above clinical cut-off or general population averages	*M(SD)*	*n (%)* above clinical cut-off or general population averages
Depression Symptoms (EPDS)	10.2 (5.49)	3067 (33.5)	9.2 (5.53)	1027 (27.1)	7.8 (4.89)	706 (17.2)	8.7 (5.23)	775 (22.7)
Anxiety Symptoms (PROMIS), t-score	58.1 (8.33)	4274 (46.9)	56.0 (8.47)	1354 (35.9)	54.8 (8.12)	1199 (29.3)	55.9 (8.1)	1166 (34.3)

M= mean; SD: standard deviation; n (%) = number of participants, presented as percentage
Clinical cut-offs/scores above population averages:
PROMIS Anxiety t-score (PROMIS): total score above 59.9
Edinburgh Postnatal Depression (EPDS): total score above 13

Depression Symptomology Trajectory Modeling

After fitting the trajectory models, the summed AIC and BIC indicated that a three-group model best fit the data. The fit of the data worsened with four and five group models (Table 1). The final model consisted of a quadratic term, with three trajectory groups, random intercept, and slope, and five equidistant knots (see Figure 1). The first and largest group of birthing individuals, the *moderate-stable depression* group, consistently reported depressive symptoms in the mild to moderate range (EPDS 8-10). The second trajectory group of birthing individuals, the *elevated-decreasing depression* group, entered the study with scores above the clinical cut-off for high levels depression symptoms (EPDS >13), which decreased slightly into the postpartum assessment, but continued to remain clinically elevated. The third group of birthing individuals, the *low-stable depression* group, entered the study with low depression symptomology (EPDS <5) that remained stable throughout the postpartum period. The average posterior probability for the individual groups were 0.70 for the *moderate-stable depression* group, 0.70 for the *elevated-decreasing depression* group, and 0.77 for the *low-stable depression* group, which align with the recommended acceptable posterior probability of 0.70 [99].

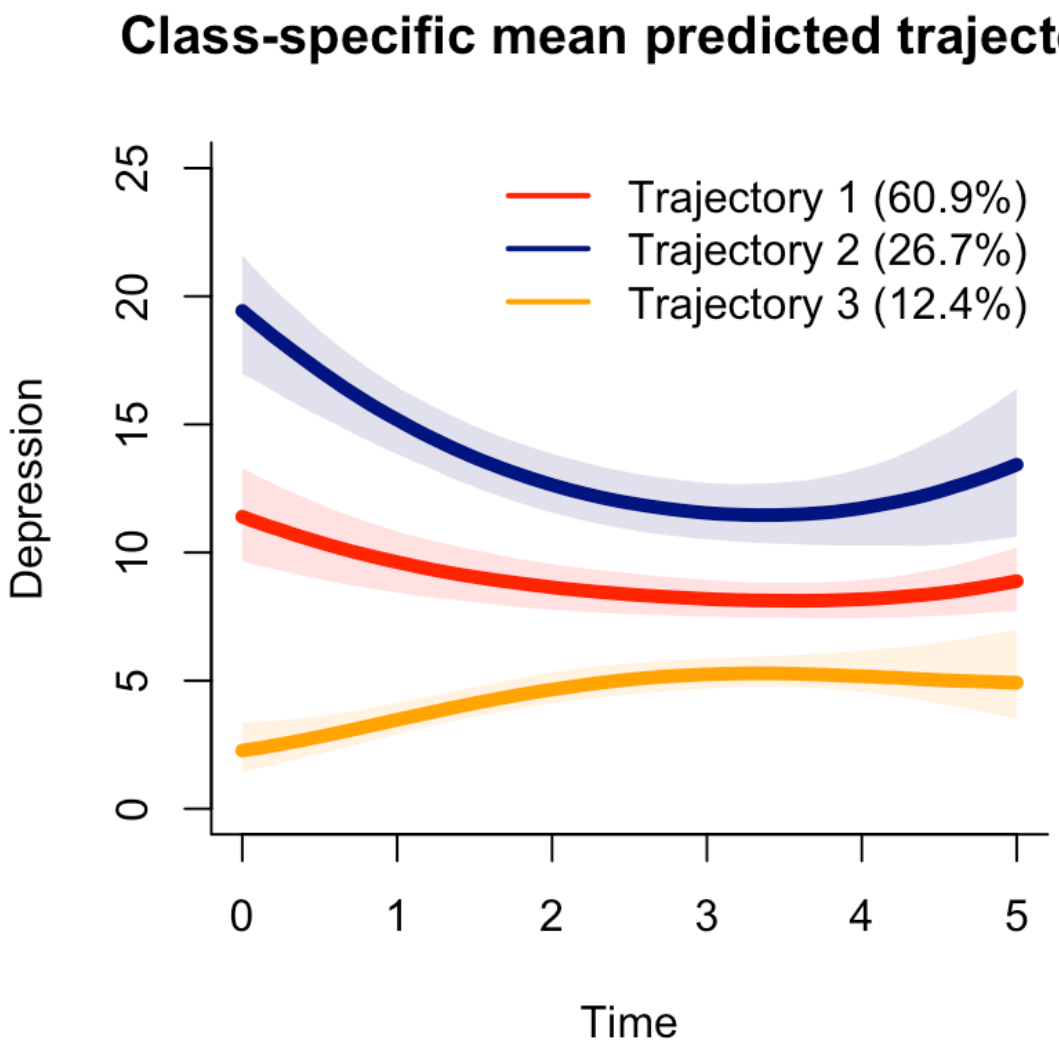

Figure 1. Maternal depression trajectories. Trajectory 1 (red) represents the *Moderate-stable* depression group (n=5762, 60.9%), Trajectory 2 (blue) represents the *elevated-decreasing* depression group (n=2529, 26.7%), and Trajectory 3 (orange) represents the *Low-stable* depression group (n=1172, 12.4%). Shaded areas represent the 95% confidence intervals. Time 1 is pregnancy (<35 weeks' gestation), Time 2 is 6 months postpartum, Time 3 is 12 months postpartum, and Time 4 is 24 months postpartum.

Depression Symptomology Trajectory Characteristics

Baseline characteristics of participants by depression symptom trajectory are shown in Table 5. It is of note that household income, history of pre-pregnancy anxiety and depression,

food scarcity, difficulty finding stable housing, baseline EPDS and PROMIS-anxiety scores, ACE-10, SCS, PROMIS sleep disturbance and impairment, changes to household income due to COVID, health concerns for self and unborn child, changes to birth plan due to COVID, and feelings of isolation were significantly different between all three trajectory groups. Maternal age, education, ethnicity, marital status, gestational age at intake, gestational age at delivery, unplanned pregnancy, number of times previously pregnant and level of social support significantly varied between the *moderate-stable depression* group vs. the *elevated-decreasing depression* group and the *elevated-decreasing depression* group vs. the *low-stable depression group*. History of miscarriage and type of delivery did not differ between trajectory groups.

Table 5. Depressive symptom trajectory characteristics

	Trajectory 1 *Moderate-stable depression group* (n=5762)	**Trajectory 2** *Elevated-decreasing depression group* (n=2529)	**Trajectory 3** *Low-stable depression group* (n=1172)	**P value**
Demographic Characteristics				
Maternal age (years)	32.00 [29.25 to 34.92]	31.41 [28.25 to 34.58]	32.17 [29.58 to 34.92]	<0.001[a,c,e*]
Ethnicity				
Caucasian	4819 (85.1)	1971 (79.3)	987 (85.2)	
Other	841 (14.9)	516 (20.7)	172 (14.8)	<0.001[b,c,e*]
Marital Status				
Married/Common-Law	5499 (96.7)	2320 (92.7)	1133 (97.6)	
Single	160 (2.8)	155 (6.2)	25 (2.2)	
Other	29 (0.5)	27 (1.1)	3 (0.3)	<0.001[b,c,e*]
Household Income (2019)				
≥$100,000+	3593 (63.4)	1164 (46.8)	795 (68.6)	
$70,000-99,000	1063 (18.8)	560 (22.5)	218 (18.8)	
$<69,999	1007 (17.8)	763 (30.7)	146 (12.6)	<0.001[b,c,d,e*]
Education				
High school or less	440 (7.7)	352 (14.1)	58 (5.0)	
Post-secondary	3647 (64.1)	1679 (67.1)	711 (61.2)	
Master's/Doctorate	1602 (28.2)	470 (18.8)	392 (33.8)	<0.001[b,c,e*]
History of pre-pregnancy anxiety	2103 (36.5)	1560 (61.7)	207 (17.7)	
Yes	3659 (63.5)	969 (38.3)	965 (82.3)	<0.001[b,c,d,e*]
No				
History of pre-pregnancy depression				
Yes	896 (15.6)	911 (36.0)	93 (7.9)	
No	4866 (84.4)	1618 (64.0)	1079 (92.1)	<0.001[b,c,d,e*]
Food Scarcity				
Often	43 (0.8)	73 (2.9)	1 (0.1)	
Sometimes				

Never	256 (4.5)	318 (12.8)	21 (1.8)	
	5360 (94.7)	2095 (84.3)	1137 (98.1)	<0.001[b,c,d,e*]
Difficulty finding stable housing				
Yes	261 (4.6)	306 (12.3)	21 (1.8)	
No	5397 (95.4)	2180 (87.7)	1138 (98.2)	<0.001[b,c,d,e*]
Obstetric Outcomes				
Gestation age at delivery	39.57 [38.57 to 40.42]	39.28 [38.28 to 40.28]	39.57 [38.71 to 40.57]	<0.001[a,c,e*]
Unplanned pregnancy				
Yes	864 (15.0)	615 (24.3)	140 (11.9)	
No	4898 (85.0)	1914 (75.7)	1032 (88.1)	<0.001[b,c,e*]
History of miscarriage(s)				
Yes	1370 (45)	653 (46.3)	259 (43.6)	
No	1674 (55)	758 (53.7)	335 (56.4)	0.517[b]
Number of times pregnant (including current pregnancy)	2.00 [1.00 to 3.00]	2.00 [1.00 to 3.00]	2.00 [1.00 to 3.00]	0.046[a,c,e*]
Delivery				
Vaginal	2424 (71.1)	840 (68.9)	529 (71.5)	
C-section	985 (28.9)	380 (31.1)	211 (28.5)	0.288[b]
Mental Health Symptomology Characteristics				
Baseline EPDS score	9.00 [7.00 to 11.00]	16.00 [15.00 to 19.00]	2.00 [1.00 to 3.00]	<0.001[a,c,d,e*]
Baseline PROMIS Anxiety t-score	57.60 [52.60 to 61.30]	66.40 [62.60 to 68.90]	46.70 [44.70 to 49.90]	<0.001[a,c,d,e*]
Social Support, Childhood trauma, Self-Compassion, Sleep				
Baseline ISEL	30.00 [29.00 to 32.00]	31.00 [29.75 to 32.00]	30.00 [29.00 to 32.00]	<0.001[a,c,e*]
Baseline ACE-10	1.00 [0.00 to 2.00]	1.00 [0.00 to 3.00]	0.00 [0.00 to 1.00]	<0.001[a,c,d,e*]
Baseline SCS	39.00 [34.00 to 44.00]	33.00 [28.00 to 37.00]	45.00 [39.00 to 50.00]	<0.001[a,c,d,e*]
Baseline PROMIS Sleep Disturbance	52.40 [46.20 to 56.10]	57.90 [52.40 to 61.70]	48.90 [43.80 to 52.40]	<0.001[a,c,d,e*]
Baseline PROMIS Sleep Impairment	48.40 [43.80 to 54.30]	56.10 [50.50 to 61.70]	43.80 [37.50 to 48.40]	<0.001[a,c,d,e*]
COVID-19 Concerns				
COVID Income				
Increased	340 (6.1)	148 (6.0)	109 (9.4)	
Decreased	2415 (43.2)	1343 (54.0)	397 (34.2)	
No Change	2832 (50.7)	995 (40.0)	656 (56.5)	<0.001[b,c,d,e*]
Life in danger (0-100)	46.00 [23.00 to 57.00]	50.50 [32.00 to 71.00]	26.00 [8.00 to 50.00]	<0.001[a,c,d,e*]
Unborn baby's life in danger (0-100)	50.00 [29.00 to 69.00]	66.00 [48.00 to 80.00]	32.00 [14.00 to 51.00]	<0.001[a,c,d,e*]
Changes to birth plan due to COVID-19				
Yes	1605 (28.8)	1072 (43.2)	218 (12.6)	
No	3962 (71.2)	1409 (56.8)	941 (81.2)	<0.001[b,c,d,e*]
Felt more alone than usual during pandemic	66.00 [48.00 to 80.00]	88.00 [73.00 to 97.00]	46.00 [19.00 to 60.00]	<0.001[b,c,d,e*]

Continuous data presented as mean (SD) per finding of non-normality (Shapiro-Wilk test, $P < 0.05$),
[a]based on Kruskal-Wallis
Categorical data presented as frequency (percentage),
[b]based on χ^2 tests
[c]Significantly Different between Trajectory 1 and 2 by Dunn-Bonferroni Post-Hoc Test ($p<0.05$)
[d]Significantly Different between Trajectory 1 and 3 by Dunn-Bonferroni Post-Hoc ($p<0.05$)
[e]Significantly Different between Trajectory 2 and 3 by Dunn-Bonferroni Post-Hoc ($p<0.05$)
N = number of participants
*denotes statistical significance ($p<0.05$)

Associations of Depression Symptomology Trajectory Membership

Table 6 presents the associations between maternal characteristics of each depression symptomology trajectory group. The *moderate-stable* depression group was used as the reference group in the regression analysis, as this trajectory group had the largest proportion of birthing individuals in the respective trajectory analyses.

Demographic Characteristics

Significant associations with the *elevated-decreasing* depression symptom trajectory membership include maternal age, ethnicity, marital status, household income, having a pre-pregnancy history of anxiety and depression, education attainment, food scarcity, and difficulty finding stable housing. The odds of following the *elevated-decreasing* depression group membership were increased for participants with ethnicities other than Caucasian (OR = 1.50 (1.33 to 1.69), p<0.001), who reported being single (OR = 2.29 (1.83 to 2.88), p<0.001), having a household income below $70,000 (OR = 2.34 (2.09 to 2.62), p<0.001), an education attainment of a high school diploma or less (OR = 1.74 (1.49 to 2.02), p<0.001), a pre-pregnancy history of anxiety (OR = 2.80 (OR = 2.54 to 3.09), p<0.001) and depression (OR = 3.06 (2.75 to 3.41), p<0.001), "often" experienced food scarcity (OR = 4.34 (2.97 to 6.35) p<0.001), and had difficulty finding stable housing (OR = 2.90 (2.44 to 3.45) p<0.001). The odds of following the *elevated-decreasing* depression symptom trajectory group additionally decreased for every unit increase of maternal age (OR = 0.96 (0.95 to 0.97), p<0.001). Relative to the *moderate-stable* depression group, having a Master's or Doctorate degree increased odds of belonging to the *low-stable* depression group (OR = 1.26 (1.09 to 1.44), p<0.001). The odds of trajectory membership to the *low-stable* depression trajectory group were decreased for participants who had a maximum education attainment of high school or less (OR = 0.68 (0.51 to 0.90), p=0.007), had a

pre-pregnancy history of anxiety (OR = 0.37 (0.32 to 0.44), p<0.001) and depression (OR = 0.47 (0.37 to 0.59), p<0.001), experience food scarcity sometimes (OR = 0.39 (0.25 to 0.61), p<0.001), and had difficulty finding stable housing (0.38 (0.24 to 0.60), p<0.001). See Table 6 for complete odds ratios and *p*-values.

Obstetrical Outcomes

Significant associations with the *elevated-decreasing* depression symptom trajectory membership include gestation age at delivery, planned vs. unplanned pregnancy, and number of times pregnant. The odds of following the *elevated-decreasing* depression symptom trajectory group additionally decreased for every unit increase of gestation age at delivery (OR = 0.94 (0.91 to 0.97), p<0.001) and increased for each unit increase in the number of previous pregnancies (OR = 1.06 (1.03 to 1.09) p<0.001). Having an unplanned pregnancy increased the odds (OR = 01.82 (1.62 to 2.05), p<0.001) of belonging to the *elevated-decreasing* depression symptom trajectory group. The odds of trajectory membership to the *low-stable* depression trajectory group were decreased if the pregnancy was unplanned. See Table 6 for complete odds ratios and *p*-values.

Baseline Mental Health Symptomology

There were significant associations with *elevated-decreasing* depression symptom trajectory membership and *low-stable* depression symptom trajectory membership with depression symptoms (EPDS) and anxiety symptoms (PROMIS-Anxiety t-scores) at baseline during pregnancy. Greater depression symptoms (OR = 9.84 (8.34 to 11.61), p<0.001) and anxiety symptoms (OR = 1.35 (1.33 to 1.37), p<0.001) during pregnancy were associated with increased odds of *elevated-decreasing* depression symptom trajectory membership, whereas decreased depression symptoms (OR = 0.02 (0.01 to 0.03), p<0.001) and anxiety symptoms (OR = 0.76 (0.76 to 0.78), p<0.001) during pregnancy were associated with *low-stable* depression symptom trajectory membership. See Table 6 for complete odds ratios and *p*-values.

Social Support, Childhood trauma, Self-Compassion, Sleep

There were significant associations with *elevated-decreasing* depression symptom trajectory membership and childhood trauma, social support, self-compassion, and sleep quality. The odds of following the *elevated-decreasing depression symptom* trajectory increased for every unit increase in ACEs (childhood trauma) score (OR= 1.07 (1.05 to 1.1), p<0.001), sleep disturbance (OR = 1.13 (1.12 to 1.14), p<0.001) and sleep impairment (OR = 1.10 (1.09 to 1.11), p<0.001). The odds of following the *elevated-decreasing* depression symptom trajectory increased for every unit decrease in ISEL (social support) score (OR= 0.95 (0.94 to 0.96) p<0.001), SCS (self-compassion) (OR = 0.89 (0.88 to 0.90), p<0.001). The odds of trajectory membership to the *low-stable depression* trajectory group were increased for every unit decrease in ACEs score (OR = 0.85 (0.80 to 0.90), p<0.001), sleep disturbance (OR = 0.92 (0.91 to 0.93), p<0.001) and sleep impairment (OR = 0.92 (0.91 to 0.93), p<0.001). The odds of trajectory membership to the *low-stable* depression trajectory group were increased for every unit increase in SCS (OR = 1.11 (1.09 to 1.12), p<0.001). See Table 6 for complete odds ratios and *p*-values.

COVID-19 Concerns

There were significant associations with *elevated-decreasing* depression symptom trajectory membership and *low-stable* depression symptom trajectory membership which include changes to income, fear life or baby's life, change to birth plan, and feelings of loneliness due to the COVID-19 pandemic. Relative to the *moderate-stable* depression symptomology group, fear of life in danger (OR = 1.018 (1.016 to 1.020), p<0.001) or baby's life in danger (OR = 1.020 (1.018 to 1.022), p<0.001). and feelings of loneliness (OR = 1.04 (1.04 to 1.05), p<0.001) were associated with increased odds of belonging to the *elevated-decreasing* depression symptom group. The odds of belonging to the *elevated-decreasing* depression symptom trajectory group were increased for participants who changed their birth plan due to the pandemic (OR = 1.88 (1.70 to 2.07), p<0.001) and for participants whose income decreased due to the pandemic (OR = 1.58 (1.44 to 1.75), p<0.001). Membership to the *low-stable* depression symptom trajectory group was decreased if participants' income decreased during the pandemic (OR = 0.71 (0.62 to 0.81), p<0.001) and if their birth plan changed due to the pandemic (OR = 0.57 (0.49 to 0.67), p<0.001). The odds of trajectory membership to the *low-stable* depression trajectory group were

increased for every unit decrease in fear their life is in danger (OR = 0.981 (0.978 to 0.984), fear their baby's life is in danger (OR = 0.980 (0.978 to 0.983), p<0.001), and feelings of loneliness (OR = 0.970 (0.969 to 0.974), p<0.001).

Table 6. Associations with depression symptom trajectory membership

	Trajectory 2 *Elevated-decreasing depression group* (Reference Trajectory 1) Odds ratio (95% confidence interval)	**P value**	**Trajectory 3** *Low-stable depression group* (Reference Trajectory 1) Odds ratio (95% confidence interval)	**P value**
Demographic Characteristics				
Maternal age (years)	0.96 (0.95 to 0.97)	<0.001*	1.01 (0.99 to 1.03)	0.084
Ethnicity				
Caucasian	Reference	Reference	Reference	Reference
Other	1.50 (1.33 to 1.69)	<0.001*	0.99 (0.84 to 1.19)	0.987
Marital Status				
Married/Common-Law	Reference	Reference	Reference	Reference
Single	2.29 (1.83 to 2.88)	<0.001*	0.76 (0.49 to 1.16)	0.204
Other	2.21 (1.30 to 3.74)	0.003*	0.50 (0.15 to 1.65)	0.257
Household Income (2019)				
≥$100,000+	Reference	Reference	Reference	Reference
$70,000-99,000	1.63 (1.44 to 1.84)	<0.001*	0.66 (0.54 to 0.79)	<0.001*
$<69,999	2.34 (2.09 to 2.62)	<0.001*	0.93 (0.79 to 1.09)	0.366
Education				
High school or less	1.74 (1.49 to 2.02)	<0.001*	0.68 (0.51 to 0.89)	0.007*
Post-secondary	Reference	Reference	Reference	Reference
Master's/Doctorate	0.64 (0.57 to 0.72)	<0.001*	1.25 (1.09 to 1.44)	0.001*
History of pre-pregnancy anxiety				
Yes	2.80 (2.54 to 3.09)	<0.001*	0.37 (0.32 to 0.44)	<0.001*
No	Reference	Reference	Reference	Reference
History of pre-pregnancy depression				
Yes	3.06 (2.75 to 3.41)	<0.001*	0.47 (0.37 to 0.59)	<0.001*
No	Reference	Reference	Reference	Reference
Food Scarcity				
Often	4.34 (2.97 to 6.35)	<0.001*	0.11 (0.02 to 0.79)	0.029*
Sometimes	3.18 (2.68 to 3.78)	<0.001*	0.39 (0.25 to 0.61)	<0.001*
Never	Reference	Reference	Reference	Reference
Difficulty finding stable housing				
Yes	2.90 (2.44 to 3.45)	<0.001*	0.38 (0.24 to 0.59)	<0.001*
No	Reference	Reference	Reference	Reference
Obstetric Outcomes				
Gestation age at delivery	0.94 (0.91 to 0.972)	<0.001*	1.05 (1.00 to 1.100)	0.040*
Unplanned pregnancy				
Yes	1.82 (1.62 to 2.05)	<0.001*	0.77 (0.64 to 0.93)	0.007*
No	Reference	Reference	Reference	Reference

History of miscarriage(s)				
Yes	1.05 (0.93 to 1.19)	0.427	0.94 (0.79 to 1.13)	0.529
No	Reference	Reference	Reference	Reference
Number of times pregnant (including current pregnancy)	1.06 (1.03 to 1.09)	<0.001*	1.01 (0.97 to 1.06)	0.555
Delivery				
Vaginal	Reference	Reference	Reference	Reference
C-section	1.11 (0.97 to 1.28)	0.139	0.98 (0.82 to 1.17)	0.836
Mental Health Symptomology Characteristics				
Baseline EPDS score	9.84 (8.34 to 11.61)	<0.001*	0.02 (0.01 to 0.03)	<0.001*
Baseline PROMIS Anxiety t-score	1.35 (1.33 to 1.37)	<0.001*	0.76 (0.76 to 0.78)	<0.001*
Social Support, Childhood trauma, Self-Compassion, Sleep				
Baseline ISEL	0.95 (0.94 to 0.96)	<0.001*	0.98 (0.96 to 1.01)	0.183
Baseline ACE-10	1.17 (1.13 to 1.22)	<0.001*	0.85 (0.79 to 0.90)	<0.001*
Baseline SCS	0.89 (0.88 to 0.90)	<0.001*	1.11 (1.09 to 1.12)	<0.001*
Baseline PROMIS Sleep Disturbance	1.13 (1.12 to 1.14)	<0.001*	0.92 (0.91 to 0.93)	<0.001*
Baseline PROMIS Sleep Impairment	1.103 (1.09 to 1.11)	<0.001*	0.92 (0.91 to 0.93)	<0.001*
COVID-19 Concerns				
COVID Income				
Increased	1.24 (1.01 to 1.52)	0.042*	1.38 (1.09 to 1.75)	0.006*
Decreased	1.58 (1.44 to 1.75)	<0.001*	0.71 (0.62 to 0.81)	<0.001*
No Change	Reference	Reference	Reference	Reference
Life in danger (0-100)	1.018 (1.016 to 1.020)	<0.001*	0.981 (0.978 to 0.984)	<0.001*
Unborn baby's life in danger (0-100)	1.020 (1.018 to 1.022)	<0.001*	0.980 (0.978 to 0.983)	<0.001*
Changes to birth plan due to COVID-19				
Yes	1.89 (1.70 to 2.07)	<0.001*	0.57 (0.49 to 0.67)	<0.001*
No	Reference	Reference	Reference	Reference
Felt more alone than usual during pandemic (0-100)	1.04 (1.04 to 1.05)	<0.001*	0.972 (0.969 to 0.974)	<0.001*

*denotes statistical significance ($p<0.05$)
Trajectory 1 = *Moderate-stable depression group*
Trajectory 2 = *Elevated-decreasing depression group*
Trajectory 3 = *Low-stable depression group*

Anxiety Symptomology Trajectory Modeling

After fitting the trajectory models, the summed AIC and BIC indicated that a three-group model best fit the data. The fit of the data worsened with the five group models (Table 2). The final model consisted of a quadratic term, with three trajectory groups, random intercept, and slope, and four equidistant knots (Figure 2). The first and second largest group of birthing

individuals, the *elevated-increasing* anxiety group, consistently reported scores above the clinical cut-off for high levels anxiety symptoms (PROMIS anxiety t-scores >59.9), which decreased slightly (although remaining clinically elevated) during the early postpartum period before increasing later in the postpartum period. The second trajectory group of birthing individuals, the *moderate-decreasing* anxiety group, entered the study with scores within the clinically mild anxiety symptoms range (PROMIS anxiety t-scores 54.9-59.9), which decreased slightly into the postpartum period, but continued to remain constant. The third group of birthing individuals, the *low-stable* anxiety group, entered the study with low/normal anxiety symptomology (PROMIS anxiety t-score <54.9) that remained stable throughout the postpartum period. The average posterior probability for the individual groups were 0.70 for the *elevated-increasing* anxiety group, 0.69 for the *elevated-decreasing* anxiety group and 0.71 for the *low-stable* anxiety group, which is within the recommended acceptable posterior probability of 0.70.

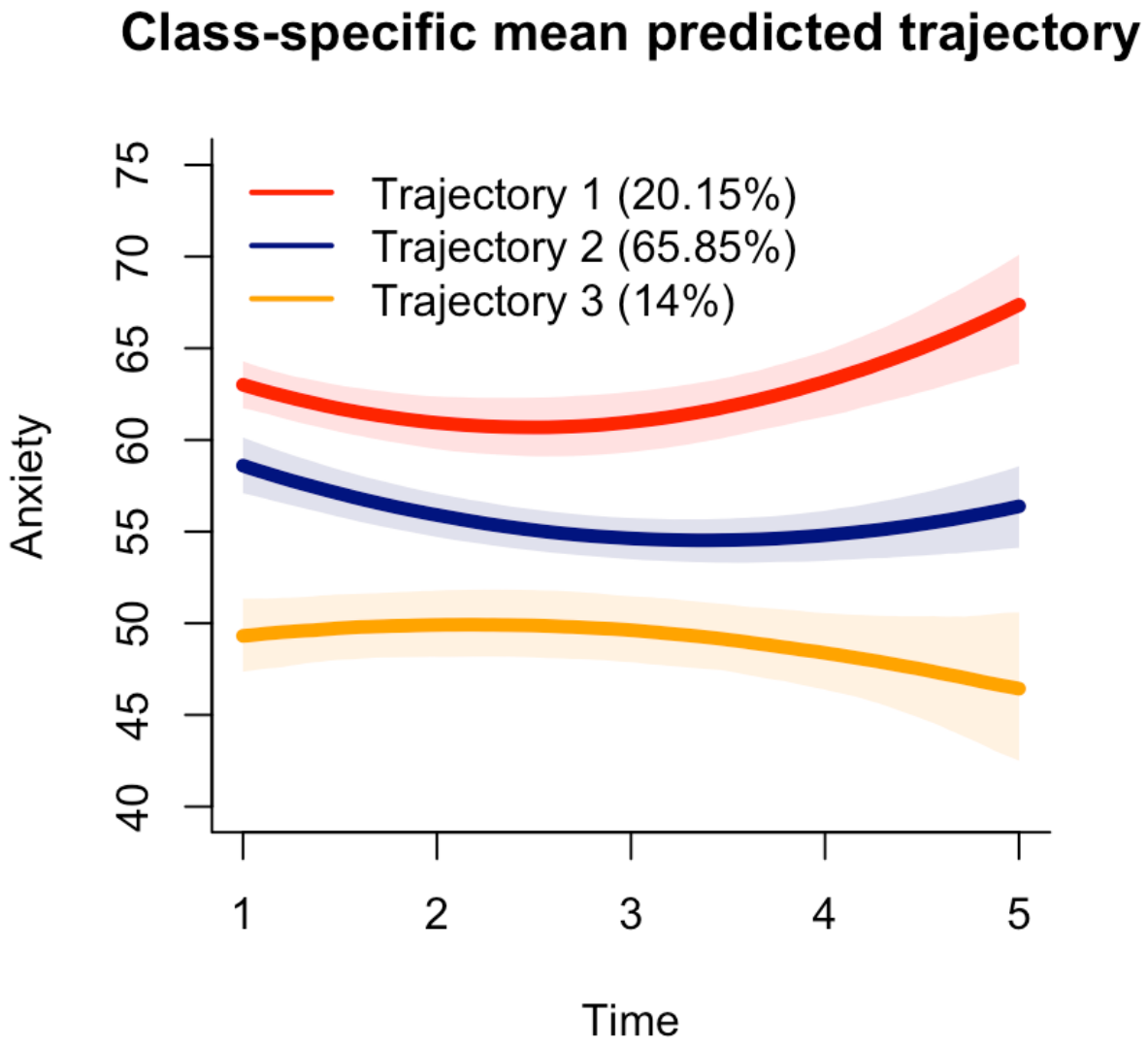

Figure 2. Maternal Anxiety trajectories. Trajectory 1 (red) represents the *elevated-increasing* anxiety trajectory group (n=1902, 20.15%), Trajectory 2 (blue) represents the *moderate-decreasing* anxiety trajectory group (n=6214, 65.85%), and trajectory 3 (orange) represents the *low-stable* anxiety trajectory group (n=1321, 14%). Shaded areas represent the 95% confidence intervals. Time 1 is pregnancy (<35 weeks' gestation), Time 2 is 6 months postpartum, Time 3 is 12 months postpartum, and Time 4 is 24 months postpartum.

Anxiety Symptomology Trajectory Characteristics

Baseline characteristics of participants by anxiety symptom trajectory are shown in Table 7. It is

of note that marital status, household income, education, history of pre-pregnancy anxiety and depression, food scarcity, difficulty finding stable housing, baseline EPDS and PROMIS-anxiety scores, ISEL, ACE-10, SCS, PROMIS sleep disturbance and impairment, changes to household income due to COVID, health concerns for self and unborn child, changes to birth plan due to COVID, and feelings of isolation were significantly different between all three trajectory groups. Maternal age, education, ethnicity, gestational age at intake, gestational age at delivery, unplanned pregnancy, and number of times previously pregnant varied between the *moderate-decreasing* anxiety group vs. the elevated-*increasing* anxiety group and the *elevated-increasing* anxiety group vs. the *low-stable* anxiety group. History of miscarriage and type of delivery did not differ between trajectory groups.

Table 7. Anxiety symptom trajectory characteristics

	Trajectory 1 *Elevated-increasing anxiety group* (n=1902)	**Trajectory 2** *moderate-decreasing anxiety group* (n=6214)	**Trajectory 3** *Low-stable anxiety group* (n=1321)	**P value**
Demographic Characteristics				
Maternal age (years)	31.4 [28.3 to 34.6]	31.9 [29.1 to 34.9]	32.0 [29.3 to 34.8]	<0.001[a,c,d*]
Ethnicity				
Caucasian	1511 (81.4)	5156 (84.2)	1093 (83.9)	
Other	346 (18.6)	965 (15.8)	210 (16.1)	0.013[b,c*]
Marital Status				
Married/Common-Law	1753 (93.6)	5902 (96.0)	1273 (97.3)	
Single	101 (5.4)	208 (3.4)	29 (2.2)	
Other	18 (1.0)	35 (0.6)	6 (0.5)	<0.001[b,c,d,e*]
Household Income (2019)				
≥$100,000+	929 (50)	3755 (61.3)	854 (65.5)	
$70,000-99,000	420 (22.6)	1145 (18.7)	271 (20.8)	
$<69,999	508 (27.4)	1223 (20.0)	178 (13.7)	<0.001[b,c,d,e*]
Education				
High school or less	241 (12.9)	522 (8.5)	87 (6.7)	
Post-secondary	1209 (64.6)	3973 (64.6)	835 (63.8)	
Master's/Doctorate	421 (22.5)	1651 (26.9)	386 (29.5)	<0.001[b,c,d,e*]
History of pre-pregnancy anxiety				
Yes	1213 (63.8)	2447 (39.4)	197 (14.9)	
No	689 (36.2)	3767 (60.6)	1124 (85.1)	<0.001[b,c,d,e*]
History of pre-pregnancy depression				
Yes	677 (35.6)	1113 (17.9)	101 (7.6)	
No	1225 (64.4)	5101 (82.1)	1220 (92.4)	<0.001[b,c,d,e*]

Food Scarcity				
Often	49 (2.6)	61 (1.0)	7 (0.5)	
Sometimes	214 (11.5)	347 (5.7)	28 (2.1)	
Never	1593 (85.8)	5711 (93.3)	1268 (97.3)	<0.001[b,c,d,e*]
Difficulty finding stable housing				
Yes	221 (11.9)	338 (5.5)	25 (1.9)	
No	1635 (88.1)	5781 (94.3)	1278 (98.1)	<0.001[b,c,d,e*]
Obstetric Outcomes				
Gestation age at delivery	39.3 [28.3 to 40.3]	39.4 [38.6 to 40.4]	39.7 [38.7 to 40.6]	<0.001[a*]
Planned pregnancy				
Yes	1487 (78.2)	5186 (83.5)	1150 (87.1)	
No	415 (21.8)	1028 (16.5)	171 (12.9)	<0.001[b,c,e*]
History of miscarriage(s)				
Yes	490 (46.4)	1505 (45.4)	278 (42.0)	
No	565 (53.6)	1812 (54.6)	335 (56.4)	0.179[b]
Number of times pregnant (including current pregnancy)	2 [1 to 3]	2 [1 to 3]	2 [1 to 3]	0.035[a*]
Delivery				
Vaginal	770 (68.0)	2476 (71.1)	544 (72.4)	
C-section	363 (32.0)	1006 (28.9)	207 (27.6)	0.065[b]
Mental Health Symptomology Characteristics				
Baseline EPDS score	15.0 [12.0 to 19.0]	10.0 [7.0 to 13.0]	3.0 [2.0 to 5.0]	<0.001[a,c,d,e*]
Baseline PROMIS Anxiety t-score	67.7 [63.8 to 70.2]	58.8 [53.8 to 62.6]	46.7 [42.1 to 48.1]	<0.001[a,c,d,e*]
Social Support, Childhood trauma, Self-Compassion, Sleep				
Baseline ISEL	31.0 [29.0 to 32.0]	30.0 [29.0 to 32.0]	30.0 [29.0 to 32.0]	<0.001[a,c,d,e*]
Baseline ACE-10	1.0 [0 to 3.0]	1.0 [0 to 2.0]	0 [0 to 1.0]	<0.001[a,c,d,e*]
Baseline SCS	33.0 [28.0 to 38.0]	38.0 [33.0 to 44.0]	45.0 [39.0 to 50.0]	<0.001[a,c,d,e*]
Baseline PROMIS Sleep Disturbance	56.1 [52.4 to 61.7]	52.4 [48.4 to 57.9]	48.4 [43.8 to 52.4]	<0.001[a,c,d,e*]
Baseline PROMIS Sleep Impairment	56.1 [48.4 to 61.7]	50.5 [43.8 to 56.1]	43.8 [37.5 to 48.4]	<0.001[a,c,d,e*]
COVID-19 Concerns				
COVID Income				
Increased	112 (6.1)	388 (6.4)	97 (7.5)	
Decreased	973 (52.7)	2661 (43.9)	508 (39.0)	
No Change	763 (41.3)	3011 (49.7)	697 (53.5)	<0.001[b,c,d,e*]
Life in danger (0-100)	51 [32 to 72]	47 [24 to 60]	25 [8 to 48]	<0.001[a,c,d,e*]
Unborn baby's life in danger (0-100)	67.0 [48.0 to 81.0]	50.0 [30.0 to 70.0]	32.0 [14.0 to 50.0]	<0.001[a,c,d,e*]
Changes to birth plan due to COVID-19				
Yes	816 (44.3)	1837 (30.4)	236 (18.1)	
No	1028 (55.7)	4200 (69.6)	1065 (81.9)	<0.001[b,c,d,e*]
Felt more alone than usual during pandemic (0-100)	83.0 [68.0 to 96.0]	70.0 [50.0 to 85.0]	48.0 [23.0 to 67.0]	<0.001[b,c,d,e*]

Continuous data presented as median [interquartile range] per finding of non-normality (Shapiro-Wilk test, $P < 0.05$), [a]based on Kruskal-Wallis

Categorical data presented as frequency (percentage),

[b]based on χ^2 tests

[c]Significantly Different between Trajectory 1 and 2 by Dunn-Bonferroni Post-Hoc Test (p<0.05)
[d]Significantly Different between Trajectory 1 and 3 by Dunn-Bonferroni Post-Hoc Test (p<0.05)
[e]Significantly Different between Trajectory 2 and 3 by Dunn-Bonferroni Post-Hoc Test (p<0.05)
N = number of participants
*denotes statistical significance (p<0.05)

Associations of Anxiety Symptomology Trajectory Membership

Table 8 presents the associations between maternal characteristics of each anxiety symptomology trajectory group. The *moderate-decreasing* anxiety group was used as the reference group in the regression analysis, as this trajectory group had the largest proportion of birthing individuals in the respective trajectory analyses.

Demographic Characteristics

Significant associations with the *elevated-increasing* anxiety symptom trajectory membership include maternal age, ethnicity, marital status, household income, having a pre-pregnancy history of anxiety and depression, education attainment, food scarcity, and difficulty finding stable housing. The odds of following the *elevated-increasing* anxiety group membership were increased for participants with ethnicities other than Caucasian (OR = 1.22 (1.07 to 1.40), p=0.004), who reported being single (OR = 1.64 (1.28 to 2.09), p<0.001), having a household income below $70,000 (OR = 1.48 (1.29 to 1.69), p<0.001), an education attainment of a high school diploma or less (OR = 1.52 (1.29 to 1.79), p<0.001), a pre-pregnancy history of anxiety (OR = 2.71 (OR = 2.44 to 3.02), p<0.001) and depression (OR = 2.53 (2.26 to 2.84), p<0.001), "often" experienced food scarcity (OR = 2.88 (1.97 to 4.21) p<0.001), and had difficulty finding stable housing (OR = 2.31 (1.93 to 2.76) p<0.001). Relative to the *moderate-increasing* anxiety group, having a Master's or Doctorate degree (OR = 1.11 (0.97 to 1.27), p<0.001). The odds of trajectory membership to the *low-stable* anxiety trajectory group were decreased for participants who reported being single (OR = 0.65 (0.44 to 0.96), p=0.030), had a household income $<69,999 (OR = 0.64 (0.54 to 0.76) p<0.001), had a pre-pregnancy history of anxiety (OR = 0.27 (0.23 to 0.32), p<0.001) and depression (OR = 0.38 (0.31 to 0.47), p<0.001), experience food scarcity sometimes (OR = 0.36 (0.25 to 0.54), p<0.001), and have difficulty finding stable housing (0.34 (0.22 to 0.51), p<0.001). See Table 6 for complete odds ratios and *p*-values.

Obstetrical Outcomes

Significant associations with the *elevated-increasing* anxiety symptom trajectory membership include gestation age at delivery and having a planned vs. unplanned pregnancy. The odds of following the *elevated-increasing* anxiety symptom trajectory group additionally decreased for every unit increase of gestation age at delivery (OR = 0.94 (0.91 to 0.97), p<0.001). Having a planned pregnancy (OR = 0.71 (0.63 to 0.81), p<0.001) decreased the odds of belonging to the *elevated-increasing* anxiety symptom trajectory group. Having a C-section increased the odds (OR = 1.16 (1.00 to 1.34) p=0.044) of belonging to the *elevated-increasing* anxiety trajectory group. The odds of trajectory membership to the *low-stable* anxiety trajectory group were increased (1.33 (1.12 to 1.59) p=0.001) if the pregnancy was planned. The odds of following the *low*-stable anxiety trajectory group additionally increase for every unit increase of gestation age at delivery (OR = 1.06 (1.01 to 1.11), p=0.010). See Table 8 for complete odds ratios and *p*-values.

Baseline Mental Health Symptomology

There are significant associations with *elevated-increasing* anxiety trajectory membership and *low-stable* anxiety trajectory membership with depression symptoms (EPDS) and anxiety symptoms (PROMIS-Anxiety t-scores) at baseline during pregnancy. Greater depression symptoms (OR = 1.27 (1.21 to 1.28), p<0.001) and anxiety symptoms (OR = 1.32 (1.31 to 1.34), p<0.001) during pregnancy are associated with increased odds of *elevated-increasing* anxiety symptom trajectory membership, whereas decreased depression symptoms (OR = 0.63 (0.62 to 0.65), p<0.001) and anxiety symptoms (OR = 0.42 (0.39 to 0.45), p<0.001) during pregnancy are associated with *low-stable* anxiety trajectory membership. See Table 8 for complete odds ratios and *p*-values.

Social Support, Childhood trauma, Self-Compassion, Sleep

There are significant associations with *elevated-increasing* anxiety symptom trajectory membership and social support, childhood trauma, self-compassion, and sleep quality. The odds of following the *elevated-increasing* anxiety symptom trajectory increased for every unit increase in, ACEs (childhood trauma) score (OR = 1.17 (1.13 to 1.22), p<0.001), sleep

disturbance (OR = 1.08 (1.08 to 1.09), p<0.001) and sleep impairment (OR = 1.74 (1.06 to 1.08), p<0.001). The odds of following the *elevated-increasing* anxiety symptom trajectory group increased for every unit decrease in ISEL (social support) score (OR = 0.97 (0.94 to 0.98) p<0.001, SCS (self-compassion) (OR = 0.92 (0.906 to 0.924), p<0.001). The odds of trajectory membership to the *low-stable* anxiety trajectory group membership were increased for every unit decrease in ACEs score (OR = 0.81 (0.76 to 0.86), p<0.001), sleep disturbance (OR = 0.92 (0.908 to 0.925), p<0.001), sleep impairment (OR = 0.914 (0.906 to 0.922), p<0.001). The odds of trajectory membership to the *low-stable* anxiety trajectory group were increased for every unit increase in SCS (OR = 1.102 (1.090 to 1.114), p<0.001). See Table 8 for complete odds ratios and *p*-values.

COVID-19 Concerns

There are significant associations with *elevated-increasing* anxiety symptom trajectory membership and *low-stable depression symptom* trajectory membership including changes to income, fear life or baby's life, change to birth plan, and feelings of loneliness due to the COVID-19 pandemic. Relative to the *moderate-decreasing* anxiety symptomology group, fear of life in danger (OR = 1.017 (1.015 to 1.019), p<0.001) or baby's life in danger (OR = 1.018 (1.016 to 1.020), p<0.001). and feelings of loneliness (OR = 1.024 (1.022 to 1.027), p<0.001) were associated with increased odds of belonging to the *elevated-increasing* anxiety symptom group. The odds of belonging to the *elevated-increasing* anxiety symptom trajectory group were increased for participants who changed their birth plan due to the pandemic (OR = 1.82 (1.02 to 2.03, p<0.001) and for participants whose income decreased due to the pandemic (OR = 1.44 (1.29 to 1.61), p<0.001). Membership to the *low-stable* anxiety symptom trajectory group was decreased if participants' income decreased during the pandemic (OR = 0.83 (0.73 to 0.94), p<0.001) and if their birth plan changed due to the pandemic (OR = 0.51 (0.44 to 0.59), p<0.001). The odds of trajectory membership to the *low-stable* anxiety trajectory group were increased for every unit decrease in fear their life is in danger (OR = 0.977 (0.974 to 0.980), fear their baby's life is in danger (OR = 0.978 (0.975 to 0.980), p<0.001), and feelings of loneliness (OR = 0.975 (0.972 to 0.977), p<0.001). See Table 8 for complete odds ratios and *p*-values.

Table 8. Associations with anxiety symptom trajectory membership

	Trajectory 1 *Elevated-increasing anxiety group* (Reference Trajectory 2) Odds ratio (95% confidence interval)	**P value**	**Trajectory 3** *Low-stable anxiety group* (Reference Trajectory 2) Odds ratio (95% confidence interval)	**P value**
Demographic Characteristics				
Maternal age (years)	0.97 (0.96 to 0.98)	<0.001*	1.00 (0.99 to 1.02)	0.587
Ethnicity				.
Caucasian	Reference	Reference	Reference	Reference
Other	1.22 (1.07 to 1.40)	0.004*	1.03 (0.87 to 1.21)	0.752
Marital Status				
Married/Common-Law	Reference	Reference	Reference	Reference
Single	1.64 (1.28 to 2.09)	<0.001*	0.65 (0.44 to 0.96)	0.030*
Other	1.73 (0.98 to 3.07)	0.059	0.79 (0.33 to 1.89)	0.604
Household Income (2019)				
≥$100,000+	Reference	Reference	Reference	Reference
$70,000-99,000	1.48 (1.29 to 1.69)	<0.001*	1.04 (0.89 to 1.21)	0.607
$<69,999	1.68 (1.48 to 1.90)	<0.001*	0.64 (0.54 to 0.76)	<0.001*
Education				
High school or less	1.52 (1.29 to 1.79)	<0.001*	0.79 (0.62 to 1.00)	0.057
Post-secondary	Reference	Reference	Reference	Reference
Master's/Doctorate	0.84 (0.74 to 0.95)	0.006*	1.11 (0.97 to 1.27)	0.118
History of pre-pregnancy anxiety				
Yes	2.71 (2.44 to 3.02)	<0.001*	0.27 (0.23 to 0.32)	<0.001*
No	Reference	Reference	Reference	Reference
History of pre-pregnancy depression				
Yes	2.53 (2.26 to 2.84)	<0.001*	0.38 (0.31 to 0.47)	<0.001*
No	Reference	Reference	Reference	Reference
Food Scarcity				
Often	2.88 (1.97 to 4.21)	<0.001*	0.52 (0.24 to 1.13)	0.099
Sometimes	2.21 (1.85 to 2.65)	<0.001*	0.36 (0.25 to 0.54)	<0.001*
Never	Reference	Reference	Reference	Reference
Difficulty finding stable housing				
Yes	2.31 (1.93 to 2.76)	<0.001*	0.34 (0.22 to 0.51)	<0.001*
No	Reference	Reference	Reference	Reference
Obstetric Outcomes				
Gestation age at delivery	0.94 (0.91 to 0.97)	<0.001*	1.06 (1.01 to 1.11)	0.010*
Unplanned pregnancy				
Yes	1.41 (1.24 to 1.60)	<0.001*	0.75 (0.63 to 0.89)	0.001*
No	Reference	Reference	Reference	Reference
History of miscarriage(s)				
Yes	1.04 (0.91 to 1.20)	0.542	0.87 (0.74 to 1.03)	0.111
No	Reference	Reference	Reference	Reference

Number of times pregnant (including current pregnancy)	1.01 (0.98 to 1.05)	0.571	0.96 (0.92 to 1.01)	0.096
Delivery				
Vaginal	Reference	Reference	Reference	Reference
C-section	1.16 (1.00 to 1.34)	0.044*	0.94 (0.79 to 1.12)	0.465
Mental Health Symptomology Characteristics				
Baseline EPDS score	1.27 (1.25 to 1.29)	<0.001*	0.63 (0.62 to 0.65)	<0.001*
Baseline PROMIS Anxiety t-score	1.32 (1.31 to 1.342)	<0.001*	0.42 (0.39 to 0.45)	<0.001*
Social Support, Childhood trauma, Self-Compassion, Sleep				
Baseline ISEL	0.97 (0.94 to 0.98)	<0.001*	0.98 (0.95 to 1.00)	0.978
Baseline ACE-10	1.17 (1.13 to 1.22)	<0.001*	0.81 (0.76 to 0.86)	<0.001*
Baseline SCS	0.915 (0.906 to 0.924)	<0.001*	1.10 (1.09 to 1.11)	<0.001*
Baseline PROMIS Sleep Disturbance	1.084 (1.076 to 1.093)	<0.001*	0.916 (0.908 to 0.925)	<0.001*
Baseline PROMIS Sleep Impairment	1.074 (1.066 to 1.081)	<0.001*	0.914 (0.906 to 0.922)	<0.001*
COVID-19 Concerns				
COVID Income				
Increased	1.14 (0.910 to 1.43)	0.256	1.08 (0.85 to 1.37)	0.525
Decreased	1.44 (1.29 to 1.61)	<0.001*	0.83 (0.73 to 0.94)	0.003*
No Change	Reference	Reference	Reference	Reference
Life in danger (0-100)	1.017 (1.015 to 1.019)	<0.001*	0.977 (0.974 to 0.980)	<0.001*
Unborn baby's life in danger (0-100)	1.018 (1.016 to 1.020)	<0.001*	0.978 (0.975 to 0.980)	<0.001*
Changes to birth plan due to COVID-19				
Yes	1.82 (1.63 to 2.02)	<0.001*	0.507 (0.436 to 0.589)	<0.001*
No	Reference	Reference	Reference	Reference
Felt more alone than usual during pandemic (0-100)	1.024 (1.022 to 1.027)	<0.001*	0.975 (0.972 to 0.977)	<0.001*

*denotes statistical significance ($p<0.05$)
Trajectory 1 = *Elevated-increasing anxiety group*
Trajectory 2 = *Low-stable anxiety group*
Trajectory 3 = *Elevated-decreasing anxiety group*

Chapter 4: Discussion

This study identified trajectories of perinatal mental health in the PdP cohort. The results indicate that there are distinct trajectories of anxiety and depression symptoms from pregnancy until 24-months postpartum. In this large pan-Canadian sample, 3 trajectory groups for depressive and anxiety symptoms were identified: *moderate-stable 60.9%; elevated-decreasing*

26.7%; low-stable 12.4% and *elevated-increasing 20.2%; moderate-decreasing 65.8%; low-stable 14%*. These findings align with existing literature [78, 80, 100, 101], which demonstrates that mental health trajectories during the perinatal period is heterogenous. 60.9% of participants experienced consistent moderate depression and 65.85% experienced consistent moderate anxiety symptoms, a finding which supports the stability of symptoms among a large proportion of women.

In comparison to previous Canadian studies that modelled five [79], three [80] and four [102] trajectories of perinatal depression and anxiety, the current study identified a 3-trajectory solution. Similarly, some differences exist between the shapes of clinical symptom trajectories. For instance, Kee and colleagues (2023) and Kingston and colleagues (2018) reported stable moderate and high symptom trajectories for the high symptom groups, and Bayrampour and colleagues (2016) reported a combination of stable, increasing, and decreasing shapes at different levels of symptoms. The differences between the three studies and the current study may be attributable to the additional postpartum assessments included in the current study, as the addition of this timepoint allowed for greater sensitivity to changes in depressive and anxiety symptoms across the first 2 years postpartum. Further, these studies were from pre-pandemic cohorts which attributes to the variations of mental health trajectory patterns.

In addition to differences in trajectory shapes and patterns of high-symptom groups, results across these studies are largely different in terms of the prevalence of clinically elevated mental health symptoms. Bayrampour and colleagues (2016) reported that 2.5% of their sample fell within their clinically high depressive symptom trajectory group while Kingston and colleagues (2018) also reported 5.6%. The clinically elevated depression group identified in this sample comprised 26.7% of the sample, where symptoms decreased slightly throughout the pandemic but continued to remain clinically elevated throughout the postpartum period, consistent with the reported perinatal depression prevalence during the pandemic [2, 103]. Similarly, the clinically elevated anxiety symptom trajectory group identified in this sample comprised 20.15% of the sample, where symptoms continued to increase in the postpartum period. This is slightly lower than general anxiety rates reported by other COVID-19-related cohorts [104, 105]. However, differences in clinical cut-offs, anxiety measures, and lack of

longitudinal COVID-19 data can be attributed to this difference. The percentage of trajectory membership in the clinically elevated symptom groups are considerably higher compared to the pre-pandemic trajectory cohorts, which demonstrates the detrimental effects the COVID-19 pandemic had on mental health [79, 102].

Risk and Protective Factors for Perinatal Depression and Anxiety Symptom Trajectories

Risk factors for the clinically *elevated-decreasing* depression symptom trajectory and the *elevated-increasing* anxiety trajectory provide additional clinical information that can be used to assess the probability of elevated depressive and anxiety symptoms. Associations between maternal characteristics and depression trajectories have been documented in the literature [79, 102, 106]. In our sample, key demographic factors that increased the odds of trajectory membership to these clinically elevated symptom groups include decreased maternal age, identifying as non-White, single or divorced, having a household income of $<70,000 and maximum education attainment of high school or less. Additionally, experiencing food scarcity and housing instability were strong predictors, as demonstrated in the literature [107, 108].

The influence of psychosocial factors on maternal mental health is well established. A significant risk factor for poor perinatal mental health throughout the perinatal period is a pre-pregnancy history of anxiety and depression. This increased vulnerability may be due to a heightened response to stressful events in individuals with prior mental health problems. Having an onset of clinically elevated depressive and/or anxiety symptoms during pregnancy significantly increased the odds of having those symptoms continue throughout the perinatal period, suggesting that screening and intervention for mental health problems during pregnancy would be beneficial for improving postpartum mental health outcomes. This finding challenges the recommended screening guidelines recently published by the Canadian Task Force who recently recommended against universal screening for depression in the perinatal period using a questionnaire-based approach [109], which contrasts with clinical guidelines in operation in the UK, Australia, and a recommendation from the US Preventative Services Task Force [110-112].

There are some mild symptom variations observed in approximately one-fifth of the sample, particularly around the postpartum period. To understand the impact of labour, we

compared pregnancy outcomes across different symptom categories. Individuals in the *elevated-increasing* anxiety group were more likely to have a cesarian birth. Consistent with previous research, decreased gestational age at birth was associated with trajectories of depression and anxiety [113]. Trajectory membership also increased for those who had an unplanned pregnancy, a finding consistent with the literature [114].

Decreased social support and self-compassion and increased adverse childhood experiences were associated with elevated depression and anxiety trajectories. A systematic review by Biaggi et. al (2016) found that lack of social support was consistently associated with an elevated risk of depression and anxiety during pregnancy [58]. Additionally, it is well-documented childhood abuse and neglect are linked to the development of various mental health disorders in adulthood [115].

Poor sleep quality (disturbance and impairment) during pregnancy was associated with trajectory membership to the clinically elevated groups. Studies have shown that sleep disturbances, including insomnia and poor sleep quality, significantly increase the risk of developing perinatal depression and anxiety [116, 117]. Addressing sleep disturbances during pregnancy through interventions has the potential to improve sleep hygiene practices and can potentially mitigate the adverse mental health outcomes associated with poor sleep quality during pregnancy.

The COVID-19 pandemic exacerbated these associations, with decreases in income, changes to birth plans, increased feelings of loneliness, and fear for their unborn child's life correlating with higher odds of having clinically elevated depression and anxiety symptoms throughout the perinatal period. These results echo the broader literature, which documents the heightened anxiety and depression experienced by perinatal women during the pandemic due to increased uncertainty and stress [81, 118]. Research indicates that the pandemic's disruptions to healthcare services, social isolation measures, and economic instability have exacerbated mental health issues in expectant and postpartum mothers [119]. The strong associations between pandemic-related stressors and adverse mental health trajectories highlight the need for targeted interventions to support pregnant individuals during such crises. The pandemic's unique and

widespread impact necessitates a revaluation of mental health support systems to better address the vulnerabilities exposed by these unprecedented changes.

Strengths and limitations

Our study has several strengths. In most regards, the PdP Study represents a large, population-based sample of urban Canadian mothers, which enhances the generalizability of the findings [83]. The longitudinal design with frequent follow-up assessments allows us to capture the dynamic nature of perinatal mental health over an extended period. Additionally, the use of validated measures for maternal depression and anxiety ensures the reliability of our results.

Our results should be considered in the context of the following limitations. First, maternal depressive and anxiety symptoms were based on maternal self-report using standardized symptom measures, not clinical diagnostic interviews, which may lead to an overestimation of prevalence [120]. In addition, the participants in our study were predominantly highly educated, with 60.3% of participants completing a bachelor's degree or higher, and 59% of participants having a household income above $100,000. Participants were primarily white (82.2%) and were married/cohabiting (94%). It is important to recognize the influence of socioeconomic status on depression and anxiety symptomology. Lower and moderate SES groups are at higher risk for chronic depression and anxiety symptoms, and pregnant lower SES women specifically are at higher risk of adverse pregnancy mental health outcomes [121, 122]. It is possible that pregnant women from more diverse socioeconomic and ethnic backgrounds have mental health experiences not adequately captured by this work and should be considered in future research.

Another limitation of this study is the influence of varying healthcare protocols across provinces (i.e. social distancing, mask-wearing, changes to birth plans, etc.) at different time intervals throughout the COVID-19 pandemic [123], suggesting that the pandemic could have differentially affected the perinatal mental health of these participants at different times. Future trajectory research should consider looking at trajectories of perinatal mental health over the course of time elapsed since the onset of the COVID-19 pandemic. Finally, longitudinal studies

extending beyond the 24-month postpartum period could provide deeper insights into the enduring effects of the pandemic on perinatal mental health.

Clinical Implications/Conclusion

Pregnancy and the postpartum period is a vulnerable time in which perinatal well-being can have intergenerational impacts, including increased risk of adverse birth outcomes and long-term negative effects on child health [124-127]. This investigation highlights the heterogeneity of depression and anxiety symptoms throughout the perinatal period and the COVID-19 pandemic, which underscores the necessity of conducting multiple mental health assessments during this period. Based on these findings, it is advisable to perform antepartum screenings for anxiety and depression to identify individuals with chronic symptoms or poor mental health during pregnancy and the first two years postpartum. These findings indicate that studies concentrating solely on postpartum depression and/or anxiety overlook the best time to investigate the factors influencing perinatal mental health and the potential benefits of interventions for both mother and child. The study also suggests that women who develop and maintain clinically elevated levels of depression and anxiety often have high-risk psychosocial and demographic profiles identifiable during pregnancy, such as low socioeconomic status, a history of pre-pregnancy mental health issues, low self-compassion, an unplanned pregnancy, and poor sleep quality. Thus, screening for high-risk psychosocial profiles during pregnancy may help in the early detection and addressing of mental health concerns, potentially improving postpartum outcomes. Further research is needed to explore the connection between these symptom trajectories and long-term child outcomes. This knowledge can assist clinicians in identifying individuals in the perinatal period who would benefit from early interventions, ultimately aiding both the birthing individual and their children.

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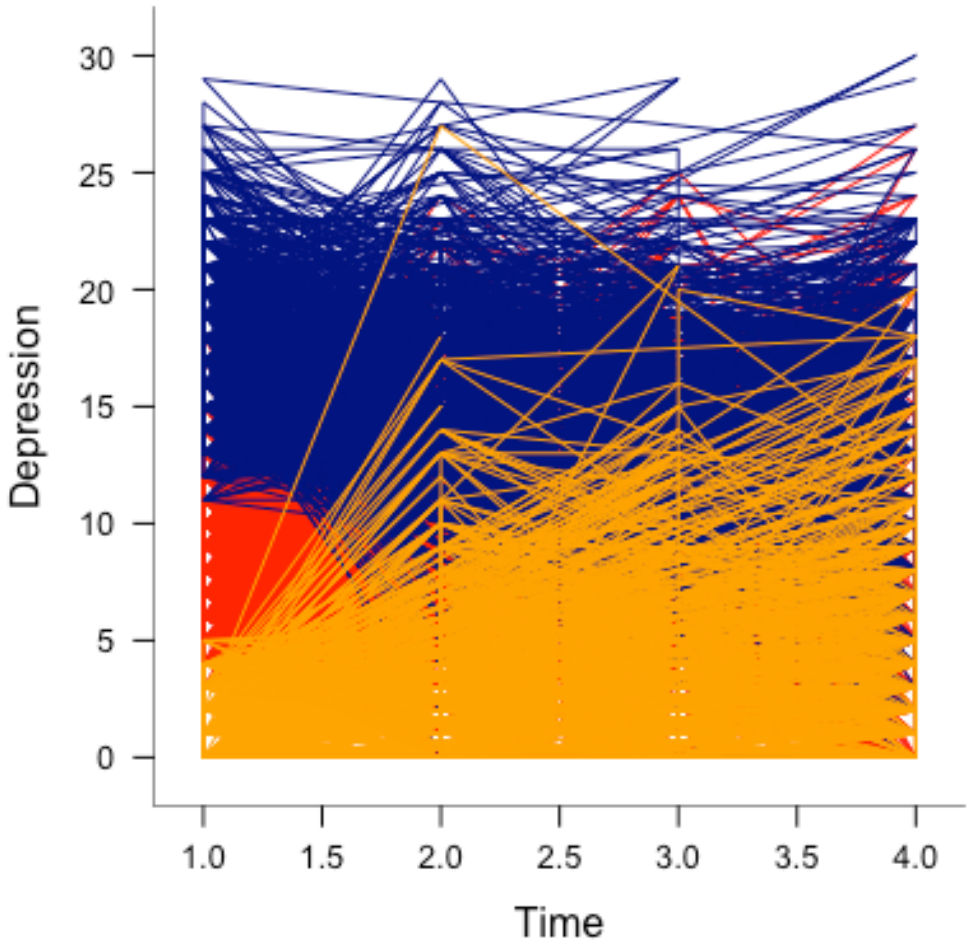
Supplemental Figures

Supplemental Figure 1: XY plot of depression symptoms (EPDS Scores) over time.



Supplemental Figure 2: XY plot of anxiety symptoms (PROMIS Anxiety t-scores) over time.